

1805 THE  
ART of METALS,

In which is

Declared the manner  
OF THEIR  
GENERATION,  
AND THE  
CONCOMITANTS  
Of Them.

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In Two Books.

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Parish in the Imperial City of *Potosi*,  
in the Kingdom of *Peru* in the *West-*  
*Indies*, in the Year, 1640.

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By the R. H. Edward Earl of Sandwich.

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# THE P R E F A C E.

Gentle Reader,

**T***Hou hast now in thy hands a Jewel  
so esteem'd in Spain and the Indies,  
that there they sell ev'n all they  
have (and the Kingdom of Heaven  
to boot) to purchase it; for having this they  
think that therewith they shall have all things  
(in this world, I mean) given unto them:  
And in that Countrey, I must tell you, it will  
go a great way toward the purchase of the  
other. Indeed there are some in all Nations  
that will sell that they have not, nor ever  
shall have; but this was a Jewel so rare that  
few had it to sell, for it was concealed like the  
great Arcanum, the Philosophers Stone, and  
only traditionally delivered to the Adepti, but  
it falling into the hands of this true Nobleman  
of England, he not envying the rest of Man-  
kind so great a Benefit, nor being willing so*

## The Preface.

great a Treasure should be wrapt up in a Napkin, he honoured and enriched our Language with it, being contented that all our Lord the Kings People should be Philosophers. Concerning him I have nothing to say, he having written his own History in such indelible Characters of Gallantry and Honour, that neither Sea nor Earth can contain them: And as he had few or none before him whom he could imitate, so I fear he hath left but few behind that will care to follow his generous Example.

The

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The manner how Mettals  
and other substances that  
accompany Them are en-  
gendred.

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## CHAP. I.

*Of the Companions of Mettals, and first of  
the Earth, and the several Colours  
thereof.*

**A**LL the inanimate things with-  
in the bowels of the Earth are  
reducible into one of These Four  
Kinds of mixtures, viz.

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Either

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Either { *Mettals,*  
          { *Stones,*  
          { *Earth or*  
          { *Juices.*

Nature produces These mingled one with the other, and because the art of separating of *Mettals* cannot be put in practice without understanding the nature of the other three, ( as will hereafter appear ) therefore I shall treat of These a little.

By the word *Earth* I do not mean that pure and simple Element, whereof the Philosophers say all mixed sublunary bodies are composed.

Neither do I mean that which is so gross as it remains mixed with *Mettal*, *Vitriol*, or other *Juices*.

But I mean such an Earthy substance as neither melts in the fire, nor dissolves in the water, as *Mettals* and *Juices* do, nor is so Compacted or hard as are *Stones*.

Some report *Aristotle* to have been of Opinion, that the pure Elementary *Earth* was void of Colour. *Strabo* affirms it to be white, because *Ashes* are  
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of that Colour, but the Miner may rest secure, that Dig he never so deep, he shall not meet with any such pure Element of *Earth* to make new experiments by, because it is not in the world by reason of the perpetual mixture of the Elements one with the other.

The Colour of the purest *Earth* that hath been found, *Cardona* would have to be, a very dark Grey: In the other sorts of *Earth* we see how rich nature hath adorned the world with variety of Colours, caused by difference of Exhalation, as *Theophrastus* says, or by difference of heat, as *Aristotle* says, and both truly; for if under *Earth*, that hath not its natural and proper colour, there be found *Mettals*, it is certain, that the exhalations from Those *Mettals* hath discoloured the ground; and if there be no *Mettal* found there, then the discolouring proceeds from the consuming power of the *Suns* heat. Besides the discolouring that comes by reason of exhalation carries a glistering and shining along with it, and the discolouring from the *Suns* over-concocti-



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on only, is obscure or Iron-colour'd, or Black.

From what is already said, considerable conjecturs may be made for the finding out of Mines in the Bowels of the Earth, by the Colour of the Ground and Cliffs, or by the Tilt ploughed up upon the Mountains, as daily experience hath shewn all over the Dominions of *Spain*.

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## CHAP. 2.

*Of the divers Smells of the Earth, and the reason thereof.*

**T**He works of Nature in producing variety of Smells of Earth, is also worthy of admiration.

Ordinarily the Earth smells well upon the fall of the first rains after the heat of Summer is past: The Dry time having baked together the moderate humidity that was in the Earth, (which is the cause from whence all good smells proceed) and the first rains dissolving that

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that again (which being exhaled by moderate heat) makes the good scent which we perceive. Some sorts of Earthen vessels also have this privilege, as that of *Estremos* in *Portugal*, and of *Nata* (in *Panama*) which are highly esteemed in *Europe* for that quality. In the famous City of *Malacca* (in the *East-Indies*) they say there is a sort of Earthen vessel that smells admirably, in so great abundance, that it is little esteemed, and they make all their most servile sort of ware of it. And in some Mines good smelling Earth hath been met withal, although most commonly that kind of Earth is of an ill scent. *Agricola* relates, that when *Henry* Prince of *Saxony* was in *Mariemburg*, there came so sweet a smell out of the Mine, which they called *St. Sebastian*, that the Prince admired thereat, and said, that he thought he was in *Calicut*, (that famous Country of the *Indies*, which for its rare smells and other excellencies hath been thought by judicious men to be the Paradise wherein *Adam* of old, and the Fathers now enjoy

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joy God upon Earth) The Mettal that comes out of the Mines (which they call *Palos*) is of a good smell, if they light not upon some bastard Mineral, that accompanies, and has infected it: and this good smell is a great sign of the richness of the stones of that Mine, and of the Earth which they get, there called *Lampos*. This experiment is ordinary in Lead or Tin Mines; and it is usual for the Miners to judge of their Oar, by the smell, as well as by the taste. Other sorts of Mettal for the most part have an ill smell, either because of their own natural distemper, or by reason of their being generally mixed with Brimston, Copperas, or other malignant juices.

Some do think, that over and above what hath been said, there is some matter in the Bowels of the Earth so stinking and abominable, that it doth correspond with the Ordure of Animals: the truth is, that there be places in the Earth that instantly kill, with a Pestilential smell. And setting aside the stories of this kind, both ancient and

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and modern in remote Countries. I shall relate two examples, where I myself was present, which was at the discovery of the rich Country of *San Christoval delos Lipes*; at that time in a beautiful high hill, that together with others encompasses the dwelling of the Miners, two Galleguares found a Mine, which at first they called after their own names, but ever since (to this present) it is called (from its effects) The stinking Mine. At first they got out of it very rich Oar (*Tacana*) between white Chalk: and as they began to sink deeper, they were forced to give over, by reason of a most abominable ill smell they met withal, which killed several of the Miners *Indians*: and so it lay unwrought for four or five years; after which time another Miner (I being then in the Country) undertook to proceed in the working of it, thinking that having layn still so long after its first opening, the ill quality would have been evaporated; but that experiment cost the lives of two *Indians* more, whereupon they forbore the work, and have

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have done so unto this day. The which I have not so much wondred at, as to see with my eyes the Ground opened in several other parts of that Mountain, at a great distance from the forementioned Mine, and in digging scarce a yard deep, such a stink came out of the ground, as forced the labourers to give over; and as I passed by those Pits a few days after, I saw divers Birds and Serpents dead in them, having been entoxicated by that poysonous smell: On the other side of this forbidden Hill (until Divine Providence make way for the Mining of the same) are built dwelling houses, and a Mill to Grind Mettals withal, adjoyning unto a Marsh Ground, which in every place where they digg'd to lay the shallow foundations of those buildings, the same smell breaks out, as hath been already described; and it comes out of the ground boiling like unto a Cellar full of Wine on the Must; exceeding troublesome and noisome unto us, though we were standing by in the open air.

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In the famous Country of Mines, *Verenguela de Pacages*, in which the *Indians* procured a Patent to dig, before that of *Potosi* was in use, because its veins were esteemed much richer than *Potosi*, and upon trial were found to be so; and the Oar gotten there inferior to none in the *Indies*. In the hill of that Country called *Sancta Juanna*, a Miner followed a very rich and plentiful vein of Silver, and intending to discover more of the like, he determined to break a hole into an old Vault\*, and set two *Indians* upon the work, who after a few blows discovered a vacuity, out of which came so Pestilential a stink, that killed the two *Indians* presently, and almost stifled others that were at a distance from them in the Mine, who nevertheless ran out, and told their Master what had happened. He made haste to the Mine, hoping to save the *Indians*, but at first entrance into the ground, upon the stairs by which they went down into the Mine, he fell down dead,

\* An usual practice among the Miners in that Countrey.

dead, and his body remained there, no body daring to go down, and take it away to bury it.

In another Mine in the same mountain, in the bottom of it, I saw a thick exhalation or poysonous vapor gush forth, making a terrible noise, and was of quality bad enough to kill one that would stay long in that Mine; putting out the Candles, when we held them to it, which is a certain sign of the malignity of the air, as hath been found by the constant experience of all Miners, and therefore deserves to be the more taken notice of.

### CHAP. 3.

*How to know the Condition of the Earth by the Taste.*

**T**He Artift in the knowledge of Mettals, before he gives his judgment, leaves no experiment untried, that may be confiderable for his information. And therefore useth his Taste, which

which discovers the pureness of Mettals, as well as smelling doth.

Pure Earth hath no manner of taste; and that Earth which is mixed with Minerals commonly hath a bad taste; because scarce any Mineral but is adust, and they be all dry, when as the very first principle of sweetness or good taste is humidity.

Now since the Earth which hath such a mixture in it is greatly disposed also to contain mettals of like condition; The curious Miner ought to make trial by tasting, holding it for a certain truth, that mettals of Gold and Silver, and others, are found as often in the form of Earth (which in the *Spanish* Miners language is called *Lamos*) as in Stones or Oar.

The taste of the Earth is gotten well by infusing it in curious water, especially if you set it upon the fire, and let it boil once or twice, and then cool again, whereby may be discerned the mixture or juice which it contains: and one that would improve this experiment may separate the water from the infusion, substantially and visibly, as shall

shall be shewn in its place, when we come to treat of the Preparation of Metals, to make them beneficial.

## CHAP. 4.

*Of the Names and Uses of some sorts of Earth.*

**I**N the books of Physick some kinds of Earth are very famous, for the effects which they have upon mans body; and it is not unnecessary that the Miner hath the knowledge to distinguish them when they come in his way.

1. *Lemnian-Earth* (so called from the Island *Lemnos*, where it is found) is very red, and much like unto red Oaker or red Lead, but it hath this notable difference, that it will not colour ones fingers in touching it, as do the others. It is esteemed as rich as Gold, and sold so weight for weight; one cause of the dearness of it is the scarcity of it in the world; and another is,

is, because they dig it only on one day in the year, being superstitiously persuaded, that that Earth of this kind only hath vertue in it, that is dug upon the  $\frac{6}{14}$  of *August*. It is a rare Antidote against any kind of poyson or Pestilence.

2. That Earth which is commonly called *Bol Armeniac*, (from the vulgar opinion, that it is found only in *Armenia*) is very like the *Lemnian-Earth* aforesaid, only it is not red, but palish, white or fallow-coloured. There is excellent good of it, and in great plenty in the *West-Indian* Mines, and particularly in the rich mountain of *Potosi*: and in those of *Oruro* divers are of opinion, that this common *Bol* is that which *Diascorides* calls *la Rubrica Synopica*: and that the Oriental *Bol Armeniac* is the true *Lemnian-Earth*.

3. There be two sorts of *Eritrian-Earth*, one pure white, the other of an ash-colour, and this last is the better, and is known by rubbing it upon polished Copper, where it will leave a tincture of violet colour. It hath vertue

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to stench blood, and to cool and heal green wounds.

4. The Earth of *Samia* is light white Earth, and will stick to ones tongue, if you touch it with it.

It is brittle, and yet will melt.

There is another sort of it called *Aster*, that is close and hard as a stone.

Both of them have the *Eritrian* vertue in them; viz. to be excellent Antidotes against poyson, or the biting of Serpents.

5. The Earth called *Chia* is white, inclining to ash-colour, much like that of *Samia*, and hath the same vertues; and over and above that, it takes wrinkles out of the face, and gives a good complexion.

6. *Selinusion*-Earth hath the same quality as the last aforementioned. The best kind of it is that which glisters much, is white and brittle, and soonest dissolves in water.

7. *Cimolian*-Earth is white, (although there be a sort of it that enclines unto purple.) The best is that which is most greasie, and is very cold in ones hand.

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It dissolves imposthumes, and little swellings, and in case of a burn it will keep the flesh from blistering.

8. The *Poigite* is almost of the same colour as the *Eritrian*, but is found in bigger lumps: it cools and refreshes the hand that touches it, and if one lick it, it will stick much unto the tongue. Its vertues are those of *Cimolian*-Earth.

9. The *Melian*-Earth is of an ash-colour like *Eritrian*, but it feels rough, and makes a noise between the fingers like a *Pomise*-stone: it has the vertue of *Allum*, (but very weak, as one may perceive by the taste) for it will make the tongue something dry: it cleanses the body, gives a good complexion, and will cure the Itch.

10. Of that Earth which is called *Ampelites*, the blackest is the best. Ground with Oyl it easily dissolves, and hath a cooling and loosening vertue: also it is used to colour hair withal; it is wholly bituminous as Jeat is also.

*Cardanus* amongst his curiosities makes mention of another kind of Earth, anciently called *Britanica*;

( from the Country where it is found ) they were fain to dig very deep Mines to come at it. It was white, and after they had separated the Plate it contained, they manured their Tith-fields with the Earth, which were put in heart thereby for 100. years after.

11. Out of Islands in the South Sea, not far from the City of *Arica*, they fetch Earth that does the same effect as the last aforementioned. It is called *Guano*, ( i. e. Dung ) not because it is the Dung of Sea-fowls ( as many would have it understood ) but because of its admirable vertue in making ploughed ground fertile. It is light and spungy. And that which is brought from the Island of *Iqueyque* is of a dark grey colour, like unto Tobacco ground small. Although from other Islands nearer *Arica*, they get a white Earth inclining to a fallow, of the same vertue. It instantly colours water whereinto it is put, as if it were the best leigh, and smells very strong. The qualities and vertues of this, and of many other simples of the new world, are

are a large field for ingenious persons to discourse Philosophically upon, when they shall bend their minds more to the searching out of truth than riches.

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## CHAP. 5.

### *Of Juices, and first of Allum.*

**T**He compositions within the bowels of the Earth are such as either will melt, or will not melt.

Those that will not melt are hard, and called Stones; or being soft and easily crumbling into very small parts, are called Earth.

Those that will melt, are either such as after they run ( by the force of the fire ) become solid and malleable; and those are Metals; or else such as do not obtain those qualities, and those are they that are called Juices.

From the mixture of the aforesaid four kinds of compositions are made eleven other sorts of Minerals, and no more.

Those who are hardned by cold, ungive again by heat, as Sulphur; but such as are condensed by heat are dissolved again by cold, and water, viz. Allum, Copperas, Salt, &c.

1. Those that write of simple medicaments speak of divers sorts of Allum, but the true Allum is that which is called Rock-Allum, whereof some is white and transparent as glas, and other some inclining to a red, and this hath the best vertue, and is mightily restraining; and therefore called by the Greeks *Estypteria*.

According to the opinion of *Galen*; lib. 4. of the quality of simples: it should be of a cold quality, because all astringent things are so, and prescribes therefore *Rupescissa* as cold in the second degree to be infused in the quintessence of *Raymundus*. But *Dioscorides*, and many others make it to be of a hot quality by its effects; but this is not a convenient place to examine the reasons of it.

2. The Allum which is called *Escayola*, is not a Juice, but the same with the

the Earth of *Samia*, which the ancients called *Aster*.

3. Neither is the *Allum scissile*, or *de pluma*, a Juice, (which is yet taken for such in Apothecaries shops) but is the Stone called *Amianto*; and it is not astringent to taste, nor consumes in the fire, although it be kept there very long, which are the particular qualities of an *Amianto*.

4. The *Allum Catino* is made of the Ashes of the herb *Anthide* or *Sosa*, (*Barrilla*, or the herb they make glas of) whereof there is great abundance in the plains of *Oruro*, and in several places of the river *Langa-Sollo*.

5. The Salt which is made of the Lees of Wine, or of the Calcinings of the Lees until they become white, is likewise called *Allum*.

the *west-Indies* abound in *Allum*, as they do also in all sorts of Minerals. In the Mines of the *Lipes*, near unto *Colo-ha*, the head Town of that Countrey, I found a vein of *Allum*; I have seen another in the hot Baths of *Ventilla*, in the high way between *Oruro* and *Chay-*



ante ; and there I saw the true *Seissile-Allum*, (or *de pluma*) with all the qualities described by *Dioscorides*. This same sort of *Allum* also is brought to *Potosi*, from another Mine near to *Porco Aylo* : and in many other parts there is of the same ; and there might of it be made in the City of *Potosi*, if they would but boil the waters *de la Quebrada*, or *Guayco de Santiago*, which are almost all *Allum*.

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## CHAP. 6.

### *Of Copperas.*

**T**He *Copperas* is a Mineral substance very like unto *Allum*, and oftentimes they are found incorporated together.

The manner of separating them, is to put the leigh that is drawn off from the Stone or Earth, which contains the Mineral, into boiling Urine, and the *Copperas* will divide from the *Allum*, and fall to the bottom, the *Allum* remaining

maining swimming on the top. The *Copperas* is sharp and biting to the taste, and of an astringent quality ; for which reason divers doe attribute unto it the properties of Sulphur, Iron, and Copper ; the vertue of *Allum*, the subtilness of Saltpeter, and the driness of Salt.

Some Alchimists have written, as if the hidden vertues of the Philosophers Stone were contained in this Mineral, whose Latin name is (*Vitriolum*) and they form a saying to that purpose, beginning every word with one of the letters of it, *viz. Visitabis Interiora Terra, Rectificando, Invenies Lapidem Veram Medicinam.* *Raymundus* saith, that it is very near of kindred to Gold, and hath the same original and principle; and it may be that is the reason why some affirm, that it is a sign of a Mine of Gold, although the experience in these Provinces doth not correspond therewith. It is ordinarily found with Copper, and in great abundance with the Black mettall, which also participates much of it, and thence takes the  
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ill smell it hath in working.

It is a very fine sort of Copperas which the Spaniards call *Copaquiras*; and the best and purest of all is that they call *Piedra Lipas*, from the Mine of it found in that Province, although a few years ago a very plentiful Mine of it hath been discovered in the Province of *Acatama*, which is of a greenish colour, and that of *Lipa* is blew. There is also whitish and yellow Copperas, which the Painters use; and different colours of it have caused several names to be given it: of this Mineral are those the Spaniards call *Mysí Sori Calobitis*, and *Melanteria*.

There is dispute enough about its temperament and qualities, as well as about that of Allum. Some not allowing it to be hot in the third degree, will yet allow it to be so in the fourth: and others on the contrary, are of the opinion of *Juan de Rupecissa*, (who I think follows *Raymundus*) that it is cold in the third degree.

It is admirable to see its effect in *Aqua-Fortis*, (in which all Mettals like Salt,

Salt, dissolve and are turned into water) and an ocular demonstration of the possibility of the transmutation of Mettals one into another; for with Copperas dissolved in *Aqua-fortis*, (without any other artifice) Iron, Lead and Tin become fine Copper: and Silver will lose of its value, and be turned into Copper also with a little help of another mettall very easie to be gotten.

By the force of a most violent heat they extract Oyl from the Copperas, which is called Vitriol, of wonderful vertue.

They make two sorts of artificial Copperas, blew and green, of a mixture of Iron, Copper and Brimston put in the fire together.

Hereafter shall be declared, how and what mischief Copperas hath caused in the working of mettals, a thing hitherto not taken notice of.

## CHAP. 7.

*Of Salt.*

SALT is no less necessary than commonly known in the world. And that which is Mineral hath the same vertue as that which is made of the Sea-water, or of the waters of brackish Lakes or Springs. The only difference is, that the Mineral-Salt is more thick and solid, whence it comes to pass to be more astringent, and not so easily dissolved in water as the made Salt is.

The Provinces of the *west-Indies* as much abound in Salt as they do in Metals; and a piece of the Sea between the *Lipes* coagulated into Christalline-Salt; as also the Salt-pits called *Garci Mendoca* are none of the most inconsiderable wonders of this new world: Those Pits are called *Garci Mendoza*, for their bigness, because they be forty leagues long, and (where narrowest) sixteen broad: and also because that some-

sometimes in the middle of that space are discovered, as it were, Wells that have no bottom, and great over-grown Fishes are seen in them. It is very dangerous travelling over this space of ground, for fear of losing ones eyesight, because the great glistering of the Sun-beams, upon that place of Chrystal, puts out ones eyes, unless they be defended with black Tiffany. There is danger of life also in that journey; it having happened, that going over that place, the traveller and his horse, and all have been swallowed up, leaving no manner of mark behind of either of them.

In the *Lipes*, four leagues from the Mines of *St. Christopher de Achocolla*, there is a small Lake upon the top of a little hill, in a Country they call *Tumaquisa*; in the middle of which Lake the water boils, and leaps up, sometimes more, sometimes less; making a frightful noise. Out of curiosity I went to see it, and found the noise and motion of it so terrible, that with reason there be very few that dare come near the mouth

mouth thereof: the water is thick to that degree, that it looks more like dirt than water: there is one small gutter where it runs over, and that water issued forth becomes red Salt, as it runs along in little channels. This is a mighty strong Salt, and has twice the vertue of common Salt in the working of Mettals.

It hath also been found to be an excellent remedy for the Dysentery; perchance it hath in it a mixture of the red Allum, that gives it both colour and spirit. Hard by this Lake runs a vein of *Piedra Judaica*; and the Country thereabouts is full of mines of Copper.

A league and a half from *Fulloma*, in the Province of *Pacages*, there be many Salt Springs, that as they gush out of the ground, in a short time become pure white Salt, (without the help of any art) and they encrease into heaps of Salt, until the winter rains dissolve and sweep them away. In the same Province near unto *Caquingora*, there be more Salt-Pits like unto the former;  
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and the like there is in several other places. In these parts also is found in great abundance of the Mine or Rock-Salt, which is massy and transparent; looking like the purest Chrystal. *Fulloma* hath in it plentiful veins of this kind of Salt. Many years ago the Inhabitants of *Curagnara de Carangas* have enriched themselves by digging of Rock-Salt; and of later years they have discovered veins of it near the River of *Langa Collo*; but the Salt-mines of *Rocalla* (which God hath created near unto the rich mountain and City of *Potosi*, that nothing might be wanting that was necessary for the working of its Oar) yields such abundance of Salt as is incredible; whereof is daily spent in the melting of Mettals at the least 1500 Quintales, and this consumption hath lasted for many years.

Besides the common vertues of Salt, which every body knows, *Arnaldo de Villa nova* (in his Treatise for the preserving of youthfulness) says, that Rock-Salt is beyond any thing in the world for that purpose: He calls it the  
Mineral

Mineral *Elixir*, and prescribes, that it be prepared with things that do not weaken it, or alter its properties ; but he does not name the ingredients, nor the manner of doing it. *Juan Beguino* in his *Tyrocinio Chymico* teaches how to extract Oyl out of it of an extraordinary great vertue ; and he says, that whatsoever is preserved in that liquor shall be kept from putrefaction for many ages : and he believes that this was it that preserved the body of the beautiful maid, (which *Rafael Volaterano* speaks of) that was found in the time of Pope *Alexander* the Sixth, in an ancient tomb so fresh, as if she had but just newly died, when as it appeared by the Epitaph, that she had been buried there 1500 years before.

## CHAP.

## CHAP. 8.

*Of Salt Ammoniac, and other Salts.*

**A**Mong all the Salts that Nature alone produceth the scarcest, but of greatest vertue, is the Salt-Ammoniac ; they call it vulgarly Armoniac, and from that name conclude, that it comes from *Armenia*, but that is not the true name of it, but Ammoniac, which in Greek signifies, Salt of the sand : and underneath the sand (of the Sea shore, I suppose) it is found congealed in little pieces by its internal heat, and the continual burning of the Sun, baked so much, that it is made the bitterest to taste of all kind of Salt. Goldsmiths use it more than the Physicians. It is one of those they call the four spirits, because the fire will convert them into smoak, and so they fly away : the other three are,

- |   |                 |   |
|---|-----------------|---|
| } | 1. Quicksilver, | } |
|   | 2. Sulphur,     |   |
|   | 3. Saltpeter.   |   |

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It hath a particular property to cleanse and colour Gold, and is put into the composition of that *Aqua-fortis* that dissolves it.

At this day we have little knowledge of the true Nitre, which was anciently made of the water of the river *Nilus*; although *Albertus Magnus* saith, that in *Goselaria* there was a mountain that contained a very rich Mine of Copper; and the water that issued out at the bottom of it, being dried, became Nitre. We know little also of *Aponitro*, which is but as it were the froth of Nitre.

*Borax* (which is called by the *Spaniards Chrysolica* and *Atincar*) is an artificial sort of Nitre, made of Urines stirred together in the heat of the Sun, in a Copper Pan, with a Ladle of the same, until it thicken and coagulate, although others make it of Salt-Ammoniac and Allum.

Nitre is bitterer than Salt, but less Salt. Saltpeter is the mean between them two, and consists of very dry and subtile parts, it grows in the walls of old Houses, and in Stables, Cow-houses,

ses, Hog-sties, and Dove-coats: it will grow again in the same Earth it was taken out of, if that Earth, be throwen in heaps and spared, and taken care of; or if ordinary Earth be cast up into heaps, and watered with brackish water, after some years it will give a great encrease, as profitable as crops of Grain.

The use of it in making of Gunpowder and *Aqua-fortis* is very well known. It is used also in the melting of Mettals, as shall be shewn hereafter.

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## CHAP. 9.

*Of Juices, which the Spaniards call Betunes.*

**T**He Betune is one of the things that does most damage of all unto Mettals, especially in the melting of them, because it burns them, and makes them become dross, if they be not cleared of the Betune before they be put into a fierce fire: There be twelve sorts of Betune,

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viz.

viz. *Asphalto,*  
*Pissasphalto,*  
*Naptal la Piedra,*  
*Gagete,*  
*Azabache,*  
*Ampelites,*

*Maltha,*  
*Piedra Thracia,*  
*Carbones de Mina*  
*Ambar de Cuentas*  
*Ambar Olorosa,*  
*Alcanfor.*

But few of these sorts are found mixed with Metals.

All Betunes are the oyeliness or fat of the Earth; and although some are of opinion, that *Alcanphor* is the weeping or Gum of the Tree *Capar*, in the Island of *Zebat*, and the Amber of another Hearb called *Polco*, (in *Spanish*) whereunto it is commonly found sticking. And to the smelling Amber they ascribe for its original a great Fish in the Sea like a Whale, because there is great resemblance between it and *Sperma Ceti*. Nevertheless that doth not hinder, that such substances also may like sweat, as it were, issue forth of the Earth; and make these Juices called Betunes.

*Asphalto* is found in the Lake of *Sodom* (or the dead Sea) in *Judea*, whereinto runneth the river *Jordan*, three leagues

leagues from the City of *Jericho*. It is nothing else but an oyly froth that swims on the surface of the water of that Lake, agitated and driven by the winds and waves a-shore, and there condenses and hardens. It is like unto Pitch, but harder, and of a better colour. Before God overthrew those wicked Cities of *Sodom*, *Gomorrha*, *Admah* and *Seboim*, that fertile valley had little of this Betune in it, as may be collected from *Gen. Chap. 14*.

These are found also in many other places and Provinces, some whereof use them to make Candles with, instead of Oyl; and although in *Peru* they have not been curious in further search then how best to work their Oar of Gold and Silver, yet by the plenty of them that the *Indians* bring, it is known that there are of them in the *Cordillera de la Chiriguanes*, in the frontiers of *Lomna*, although they have little access to them, because they be in the power of the *Indians*, that maintain war against the *Spaniard*.

The *Pissasphalto* is a natural composition

sition of *Asphalto* and *Paz*, and so the colour of it declares ; and for want of the true natural *Pissasphalto*, they counterfeit it of those two materials.

*La Napthe* is a sulphurous liquor, sometimes white, and sometimes black also, and is that which is called Oyl of *Peter*, of admirable vertue to cure old pains, proceeding from cold causes: It will draw fire to it ( as the Loadstone does Iron ) with that force, that it will take fire at a great distance from the flame, as hath been confirmed by the miserable experience of the *Conde de Hercules de Icontrarii*, of the Country of *Ferara*, who having a Well in his ground, the water whereof was mixed with *Petreol*; and by some breaches or cracks in the Well, much of this water ran to waste ; commanded it to be repaired ; the Laborer that was let down into the bottom of the Well desired a Candle, the better to see his work, which was furnished him in a Lanthorn, and immediately through the holes of the Lanthorn the *Napthe* sucked the flame into it self, and set fire on the whole

whole Well, which discharged it self instantly like a great piece of Cannon, and blew the poor man into pieces, and took off an arm of a Tree that hung over the Well. The *Conde* himself told the story to *Matiolo*, who reports it in his *Dioscorides*.

*Asphalto* and *Pissasphalto* melt in the fire as Pitch or Wax, and by that they are distinguished from the *Piedra Gagate*, or *Ascabache*, and also from Pit-coal, which burns and consumes it self away like Tea, or any other sort of wood. As yet I have not heard whether there be any Betunes in these Provinces, although I perswade my self there be, if they were sought for.

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## CHAP. 10.

### *Of Sulphur and Antimony.*

Sulphur is a Mineral the most universally known of any. It is made of an Earthy unctuous substance, and very hot, to that degree, that it is

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esteemed to be nearest of kin to the Element of fire, of any compounded substance. The Chymists call it, the Masculine seed, and Natures first agent in all generation: and they say, that the difference between one thing and another, arises from the divers preparations and mixtures of Sulphur and Quicksilver. It hath happened to an Apothecary, that going about to make a salve compounded of those two materials; he has found the result to be a Plate of fine silver. After many considerations of this substance, *Thophrastus Paracelsus* proceeds to contemplate the wonders produced by Sulphur, and saith, that God by an especial providence hath concealed those mysteries; and that it is an evident confutation of those, who oppose the transmutation of Mettals; for this Mineral doth effect it: and he teaches a way to make an Oyl, called in *Spanish* (*Epatica Sulphuris*) which turns Silver into Gold. And *Heliana*, the Author of a book, called (*La Disquisition*) teaches the same thing with raw Sulphur, to shew the

the possibility of it, although it be in very little quantity. The smoke of it helps to fix the Quicksilver, and turn it into Plate, whereof there be many eye-witnesses in these Provinces. And this Sulphur distilled in a Glass-Still, makes the Oyl of Sulphur, of such rare and admirable vertue, especially for the French Pox, taking three or four drops thereof every morning for a week together in some liquor proper to convey it in. It is good to cure the difficulty of Urine, and the pains of the Gout, and many other things, as you may see in *Diodorus Euchiente*, and divers other authors. There is abundance of Brimston in the Province of the *Lipes*, and in the confines of the *Pacages*, and in *la Puna de Tacora*, or *los Altos de Arica*, and in many other parts besides, it's found incorporated with Mettals in the richest Mines of *Peru*.

The Antimony, or *Stibium*, which some Miners call by the name of *Alcahole*; and others (particularly in *Oruro*) call it *Macasote*; 'tis a Mineral very like unto that they call *Sorocho*, or  
Lead,

Lead, that is very porous; it shines very much, and is brittle; some of it is of a reddish yellow colour, and some there is more inclining to white, and very finely grained, as Steel shews where it is broken.

It is made of a very corrupt, and imperfect mixture of Brimston and Quicksilver, and seems to be an abortion of Nature, and the *Embrio*, which would become mettall, if it was not taken out before its time.

*Porta Vegino*, and others do teach a way to draw out of this a kind of Quicksilver, which they call *Regalo*; but it is inclining to red, and has not so lively a motion, as the ordinary Quicksilver. By *Aqua-fortis* also Brimston (whereof it is compounded) is gotten from it in its proper form of a green colour, and burns as ordinary Brimston does.

*Basillius Valentinus* in his Triumphal Chariot of Antimony, having spoken of many of its excellencies, afterwards teaches how to make of it a Fire-stone, (as he calls it) which will turn other mettals

mettals into Gold. *Paracelsus* writes much also to the same effect; and other Chymists with a continued voice do speak of an oyl, which is gotten from Antimony for the same purpose: but from a more certain and necessary experience does *Matiolus* commend his ointment, for the curing of old Ulcers, and for other medicinal uses.

*Stibium* has a drying and astringent vertue, and the preparation (which they call) *Hiacint* is held to be a very strong purge, and a provoker to vomit. This *Alcohol* is very commonly found comprehended in the Silver-Oar, and particularly in that which in *Peru* is called the black Oar; nevertheless in many parts it is found in a body by its self. It does a great deal of mischief in the working of Mettals, as the Betune and Brimston does, and therefore must carefully be gotten out before-hand, as shall be shewed hereafter.

## CHAP. II.

*Of Marcasita, Orpiment, and Sandaraca.*

**M***arcasita* is also called *Pyrites*, which signifie a stone of fire, because being struck with Steel, it yieldeth fire in greater abundance, than any other Mineral: some will have it to be begotten of an undigested vapor, others that it is composed of a courser sort of Brimstone, or Betune, and stone; it grows in all sorts of Mines, but especially where there is Copper, and the black Silver Oar, whereof it doth much participate, and perhaps that is the reason, why *Dioscorides* saith, that the *Marcasita* is a kind of Copper: and notwithstanding *Albertus* and others do think the *Marcasita* contains no Mettal in it; yet experience has taught the contrary; for the farmers of the Mines of *Monferrat en los Chichas*, when they began to dig those Veins, they found the Oar to contain

as much Silver as it did of *Marcasita*: and in this mountain of *Potosi*, and others, there is a fine sort of this *Marcasita*, which is found incorporated with the black Silver Oar, and is a certain sign of its richness; there be as many kinds of *Marcasitas*, as there are of Mettals, whose colours they represent; the most common sort looks like Gold; being put in the fire, it smells like Brimston, and flames much, which is a sign it is compounded, as has been said before.

Gold, Silver, and Copper are usually found contained in it: it is a great hinderance to the melting that Oar where it is incorporated, dividing the Quicksilver into very small particles, as shall be shewed hereafter, together with the proper remedies for it.

*Orpiment* and *Sandaraca* are of the same nature, and vertue, and are only made to differ by their greater or lesser concoction in the bowels of the Earth. *Sandaraca* being nothing else, but *Orpiment* well concocted, and by consequence thereof, heightened in vertue,

as is demonstrated by putting *Orpiment* into a Fining-pot, and setting it on the fire, whereby after a convenient concoction, it will become red, and of as lively a colour, as the most perfect natural *Sandaraca*. Where *Orpiment* is found, it is a certain sign of a Mine of Gold, wherof also it always contains some seed or little particle; as *Pliny* reports, in the time of the Emperor *Caligula*, that he did then extract some Gold out of it: since that time, it has not been attempted, because the cost does much exceed the benefit.

The best sort of *Orpiment* is that, which is of a shining Gold colour, that is not fast compacted, and easily breaks into scales, ( as it were ) the most perfect *Sandaraca* is that which is reddest, purest, and the most brittle, of the colour of *Cinabrio*, ( an *Indian* word, of a Gold colour ) and it hath a strong smell of Sulphur, whereby, as also by its other qualities, and medicinal virtues it is distinguished from *Sandix*, which is of the same colour, and is made of *Albayalde* well burnt in the fire, which

which some also improperly call *Sandaraca*; these are poyson, by reason of their strong corroding, and burning quality, not only upon the bodies of Animals, but upon Mettals also, in like manner as antimony, or Brimston, or other dry Minerals; for by reason of their oily parts, they take fire, and being mingled with Mettal, they burn and consume the moisture thereof whereby the mettall moulders away, and is lost: There be other Juices, that are scarcer, and not commonly known, as they report of one, that is found in the Mine of *Anchergo*, which is white and hard, and poysons the cattel that taste it: and it maybe, of this kind was that vein which persons of good credit have told me was found in the Province of *Conchucos*, in the Archbishoprick of *Lyma*, with which the inhabitants of that Country used to kill those they had a mind to be rid of; to prevent which wicked practice, the holy Archbishop *de los Reyes*, *Don Soribio Alonso de Magrobejo*, commanded the Mine to be stopt up.

## CHAP. 12.

*Of the Generation of Stones.*

**I**T is most certain, that there is some very active principle or vertue that operates in the generation of Stones, as well as upon the rest of the matter of the Universe, that is subject to generation and corruption; but the difficulty lies in knowing what that principle is, because it operates in no determinate place, but sometimes Stones are made in the air, in the clouds, in the earth, in the water, and in the bodies of Animals.

*Avicena* and *Albertus* think the matter, whereof Stones are made, to be a mixture of Earth and Water; and if the greater part be Water, it hath the name of liquor; but if the greater part of it be Earth, then it is called dirt or clay.

That clay which is fit to make Stones of, must be tough, and slimy, such as Bricks,

Bricks, Pots, and other Earthen vessels are made of; for if it be not such, as soon as the fire hath consumed the moisture of the dirt, it will not hang together, but crumble into earth, and dust: it is also necessary, that the liquor, which is to be converted into Stone be very slimy; the experience whereof we find in our own bodies; the Physicians being generally of an opinion, that the Stone is begotten in the reins and bladder of slimy tough humors, baked hard by the heat of the body: this opinion touching petrifying liquors, is confirmed past all question, by the experiment of that famous water in this Kingdom of *Pern*, near unto *Guanacavelica*; which they take and put into moulds of what form and bigness they please, and expose it to the Sun, for a few days, whereby it is made perfect Stone, and they build their houses with it: all the cattel that drink it dye; and from what has been said before, it is not hard to conjecture the reason.

In a mountain called *Pacocava*, a league from the Mines of *Verenguela de Pajages*,

*Pajages*, there be Springs of this liquor, (the colour whereof is whitish, inclining to yellow) that as it runs along, condenses into very hard and weighty Stone, of different shapes. Moreover any porous substance that can suck this kind of liquor into it, is apt to be turned into Stone; and of those I have seen Trees, and Limbs and Bones of Beasts turned into hard Stone. In the City *de Plata* I have seen sticks of wood taken out of that great River, (of the same name) so much of which as had remained covered with the water, being converted into very fine Stone: I saw also the Teeth and Bones of Giants, that were dug up in *Tarija* turned into heavy and hard Stone.

Stones have their substantial forms, which makes them differ specifically; yet because we cannot come to the knowledge of them; in our definitions we are fain by way of Periphrasis to make use of accidents and properties. Every several form of the Stones is accompanied with particular virtues, as remarkable as those of Animals or Plants,

Plants, and proportioned to the length of time Nature takes in its generation; but because Plants and Animals are to have so different dispositions, and to produce such various and admirable effects, they cannot be of so uniform, and well mingled a temperament as the Stones are, nor is their soft and gentle substance capable to endure so much force; as neither is the hardness of the Stones fitted for the producing variety of several shapes, and therefore in them are found no leaves, flowers, fruits, hands nor feet, as in Plants and Animals, though they have a greater vertue of another kind.

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## CHAP. 13.

*Of the Differences of Stones one from another.*

ALL sorts of Stones are reducible under some of these five following species.

1. If they be small, very scarce, and  
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very hard of substance, and have lustre, they be called precious Stones.

2. If they be of great magnitude, (although they be rare and have lustre) they are some kind of Marble.

3. If in breaking they fall into splinters or scales, they are a sort of Flints.

4. If they be of a small grain, they be Pebles.

5. Those that have none of the above-said qualifications, are Rocks or ordinary Stones.

But the Miners for the better distinction of the sorts of Stone, wherein Mettals are engendred, use peculiar names for them; for example, a kind of Stone like Peble, which contains Gold, Silver, or any other Mettal they call *Guijos*, which breeds a richer vein of Mettal than any other Stone.

*Cachi*, another sort of Stone white like Alabaster, soft and easie to break in pieces, is all this Country called Salt. Much Lead is engendred in this kind of Stone, in the veins of (*Metales pacos*) which is the name the Miners here give unto their Silver Oar.

*Chumpi*

*Chumpi* (which is so called, because it is of a grey colour) is a Stone of the kind of Esmeril mixed with Iron; it shines a little, and is very hard to work, because it resists the fire much. It is found in *Potosi* and *Chocaya*, and other places, with the black Mettals and *Roscleres*.

*Lamacrudria* is that Stone which is close compacted, and solid, and shews not the least grain nor porousness when you break it, and is of a yellow colour, and sometimes high coloured, as blood-red.

*Almaclaneta* is the name they give another kind of Stone, which is very solid and weighty, of a dark colour, always found in the company of rich Mettals, which are engendred in it, when it comes to be corrupted and rotten; as in like manner is done in the *Gouijos*. It grows upon the Flints of the Gold Mines, and those of Copper and Silver.

*Amolaclera* (or Whetstone) is that ordinary Stone, which is commonly made use of for that purpose, and so

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known to every body. Divers rich Mettals grow upon it, but most commonly (*los Cobrijcos.*)

The veins of Silver are rare and inconsiderable, that are found in Pit-coal; although it be a more proper bed for Gold.

Other Stones that grow in Mines, or cleave unto the Mettal, they call *Ciques*, (and also *Caxas*) which are rough and uneven, but not very hard, nor very spongy, and commonly have nothing of Mettal in them, although in some rich Mines they are infected with some little, by the vicinity of the Oar.

The Stones of *Potosi*, called *Vilaciques*, have been, and are very famous, for the abundance of Silver gotten out of them; and are one of the ingredients that make this Province, without comparifon. *Vila* fignifies blood, (in *Peru*) or any red thing; and for the streaks of red this Stone hath in it, they call it *Vileciques*.

CHAP.

## CHAP. 14.

### *Of Precious Stones.*

**P**recious Stones are either transparent, as the Diamant is, or obscure, as the Onix, or between both, as the Sandonyx and the Jasper. It is the water which is the principal cause of clearness, and the Earth of the opacity of them. So that the reason why they excel one the other in lustre and transparency, is from the variety of humors congealed together to compose them, which are some of them more pure and clear than others.

White Stones are made of a humor almost like water, and so are more clear and transparent; such is the Chrystal and the (*Iris*) so called, because being held opposite to the Sun-beams, it much resembles the Rainbow.

The Diamant is engendred of a less clear humor, than the Chrystal or Iris, and so is more obscure than either of

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them.



them. The same variety may be observed in all precious Stones of what colour soever they be; whether composed of Juices or humors that be green as the Emerald, and the Prasma; or of blew, as Saphir, the Caiano, and some sort of Jasper, or red, as the Ruby, or purple, as the Jacynth and Amatist, or Gold-colour, as the Chrysolites and Topaz, or of mingled colours, as the Opalos.

In like manner it is to be imagined, that the other sorts of Stones that are not transparent, are engendred of a mixture of black and thick humors; an instance whereof we see in water, which though it be naturally white and clear, yet mingled with Ink or such like liquor, it loseth its transparency, though not the lustre of its superficies.

The different colours of the juices or humors aforesaid, arises from the various mixture of black and white matter, whereof the Stones are engendred: Although *Raymundus* and many others attribute it more immediately to the variety of Mettals, of whose purest liquors

liquors precious Stones are engendred; in the heart of other hard Stones, whether that liquor hath penetrated, and thereby much refined it self. And that in estimation, precious Stones hold in proportion to the Mettals of which they are engendred, as the Ruby to Gold, the Diamant to Silver, the Emerald to Copper, and the rest in like manner. In his *Compendium* of Transmutation, dedicated to *Robert* King of *England*, he doth particularly teach the way of making artificial precious Stones (by a mixture of the waters of divers Mettals) as beautiful, and of the same vertue as the natural ones are. A knowledge (over and above other excellent qualities of that rare person) which seems to outgo humane capacity. But it is the easier to be believed, because we see Esmalts made of divers colours, by a composition of Minerals ground to powder and glass, and false Stones made in the same manner.

Transparent precious Stones have many faults in them, which by reason of their clearness are sooner discovered by

by the eye, than those in common Stones; as spots appear the most in the finest garments; and it is rare to find a Stone that hath not some defect or other; either spots, or hair, cloud, shadow, salt, or other thing subject to be engendred in them, because the humor of which it is made is not all of one colour. A shadow arises from the humors being more obscure in that part. A cloud comes from the humors being too white in that part. Hairs, which are oftenest found in the Saphir: and salt which particularly hurts the Opalos, as Lead doth the Emerald, are impediments of different colours from the true colour of the Stone in which they are.

CHAP.

## CHAP. 15.

*whether there be precious Stones in the Kingdom of Peru.*

**H**itherto the industry of the people of these Provinces hath been principally applied in the search after Gold and Silver, and they have neglected the enquiry after precious Stones, although there have been and are many notable indications, that this flourishing Kingdom wants not this prerogative also.

there is a constant report, and I myself have heard it in the Country of the *Lipes*, that in the adjoining Province of *Atacama*, there have been found excellent Diamonds; and that in exchange for a little *Cocus*, worth not above two Reals, an *Indian* old woman sold a handful of rough Diamonds, which in *Spain* were worth many Ducats. It is a Country full of beautiful Stones to see to, and therefore may very well be supposed to have riches in it.

There

There be store of Amatists in a wood called by that name, which stands hard by the Mines of *Esmeruco*. And in the rich Mine of St. *Elizabeth* of new *Potosi*, there be found rich and well grown Amatists among the Silver Oar. There are of the same kind of precious Stones in *Paraguay* and *Buenos Ayres*; they are engendred in (*Papas Lanadas*) one or two fathom under ground, in a very hard and heavy Flint Stone, which they call a *Coco*, because like the Coco-nut; it is about the bigness of ones head. The Amatist within will be as big about as two fingers, naturally coagulated into shapes like fine lace, and is more or less mature and perfect, according to the condition it was in when the Coco burst, which it doth of its own accord, and then makes a report like a piece of Ordinance, and makes the Earth near it tremble for a good while; and that just over it to break and open; by which tokens men go to the place, and dig for the Coco, which they find split into two or three or more pieces. This is a thing well known, and common in these

these parts of the world. Near unto the place called *Aqua Caliente*, (for the hot water that there gushes out) in the way between *Potosi* and the *Lipes*, there is a (*Pampa*) full of a pure transparent Chrystalline Stone, formed by nature into several angles that meet in one point: I always pickt up some of them when I went that way; admiring their beauty; for exposing them to the Sunbeams, they looked all like so many several Suns. The largest that I saw of them was about the bigness of ones Thumb.

Of this sort, although much smaller, yet there be abundance in the Countries of *Callapa* and *Julloma*: in the Province of *Pacages* I gathered some also naturally cut like Rose-Diamonds, as big as large Pease; and washing the sand, I often observed amongst it little small points of the colour of Gold, and transparent, like unto the best Topaz; and others of that sort as big as Barley-corns, which if they were bigger, would be of great esteem, and no doubt but such might be found, if hearty industry

dustry were employed thereabout.

The Stones of the Mine of *Camata*, in the Province of *Larecaxa*, do vi in beauty with the Diamond, and are worn in Bracelets and Rings in this Kingdom.

In the great Head land of *Arica*, between the Rocks within the Port, there is a Mine, whence they get Stones transparent as Diamonds, and very near as hard, whereof also they make Jewels.

The best Turqueyes are found in *Atacama*: I have seen one in the *Lipes*, as big as a twelve-pence *English*. The *Indians* of this Country esteem it great bravery to have Necklaces and Bracelets of small Turqueyes curiously composed. The men wear great ones of this kind about their necks, like Gold chains. They wear such chains also of green Stones; and the officers of their Armies esteem them most of all, and account them the best ransom a prisoner can give them.

Pearls also are gotten in the coasts of *Atacama*, and in the *Mexillores*, which are

are taken out of Oysters, and brought hither to sell: it is very ordinary to find Pearls in the dressing or eating of the Oysters.

I have little knowledge of the fertility of the lower Countries in these kinds, because they have little or no commerce here. Besides my chief intention is to give your Lordship information of the Mines of the Provinces subject to your own Jurisdiction, and that I have seen in person. Nevertheless at the time of the first Conquest of these Countries, there were found many and very large Emeralds in the hands of the Natives, as appears by the Histories thereof.

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## CHAP. 16.

### *Of other sorts of Stones.*

**I**T doth very little import the owners of Mines (for whose sake principally, by your Lordships command, I have written this Treatise) to discourse more

more particularly of other Stones, although the common sort of Stones, because they are so, are little enquired into or understood; and when in Mines they meet with some Stones of rare colour and transparency: their beauty would invite the Miners esteem, if the covetousness after Gold and Silver, which they seek for, did not blind their eyes and understandings, so that they cannot attend to look after them. But because I have given an account of all Minerals together; and that Marbles are of next estimation unto precious Stones: it is but justice to treat a little of those Marbles we find in these Provinces, which I believe equal to any that we read of in story.

The Province of *Atacama* above all others best deserves to be curiously enquired into, by able and experienced Artists; for it produces Stones of such various colours, and beautiful gloss, and lustre, that only the great quantity, and abundance of them hinders them from being reckoned among the precious Stones.

This

This whole Kingdom is full of curious Altars made of these Stones; and very many of them have been carried into *Europe*; and they have not been wrought for any other purposes; yet either for want of Stone-cutters to work them, or because most of us in these parts have in our eye to return home again into *Spain* with great estates, and care not for perpetuating our fame in these parts, by sumptuous buildings; for which these sort of Stones were very fit materials.

There is a Stone in this Imperiality, worthy for its variety, lustre, and greatness, to be presented to the view of the King our Sovereign Lord. It is six Palmes in length, and one Palme six Inches less in breadth, and two fingers thick: it is in form like a Planck or large Table; it is full of delicate clouds, made by the composition of its colours: there be some red, and shining transparently, others more obscure, as black, yellow, green and white: upon the blackest spot in all the Stone is resembled snow, as it were fal-

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ling

ling upon it, or milk, according as the white happens to be mixed with shadow.

In the Mines of *Verenguela de Paca-gues*, there be other Stones, not inferior in the nobleness of their substance and lustre, to those of *Atacama*, although they have not that variety of colours. They be white as Alabaster, and transparent; and because that colour is not equally distributed, it causeth, as it were, clouds, which gives much gracefulness and beauty to the Stone: no liquor will sink into them, they be so hard, like unto natural Crystal. The Font in the Church of *Julloma* is a very large one, and yet is made of one of these Stones. And though it be six fingers in thickness, yet you may see plainly through the sides of it the light of a Candle stuck up in the middle. In the Jesuits college, at the City of *Paz*, there is a famous Water-pot of this Stone, through whose sides you may see the water rise as it is poured in, just as if it were through transparent Glass.

CHAP.

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CHAP. 17.

*Of some accidents happening to Stones, and the Causes of them.*

BESIDES shining and transparency, which as hath been said, is found in divers Stones, and in the common sort of Stones is not found; there be also other accidents that accompany them, *viz.* Hardness and Softness.

Hardness is so essential to all precious Stones, that they be not held for such, upon whom the File will make any impression. If the matter of which the Stone is compounded be tough, and dried by a violent fire, till the moisture be consumed, it causeth hardness, because it contracts and condenses the matter within it self. If the matter have little or no toughness, then the moisture being easily dried away by heat, and the earthy part burnt, there will remain a Stone soft and brittle, Also the Ambient cold will condense

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matter and make it hard, as we see in Stones congealed thereby, the which will dissolve again by the fire, and the congealed humor relax and run: Stones that want moisture enough to glue their terrestrial parts together, when they be put into the fire they break into small pieces: and those which are driest of all do resolve into dust or lime by the fire.

Some Stones are porous, others massy and well put together. The first arises from the unequal and ill mixture of the wet and dry parts whereof it is compounded, so that the heat exhaling the moisture, where no earthy substance was mingled with it, leaves a hollow place, or pores, which make spongy Stones. As for the opposite reason, we see the contrary effect in massy Stones. Stones are found of various figures, and causing as much admiration as most things in nature. Perhaps it may come from the various mixture, colours, and veins of Stones; as you may see in their clouds and spots represented towers, sheep, and other

Animals

Animals and figures. And in Lead poured out upon water, often happens the like. The story is famous of the Agates of King *Pirrhus*, that represented *Apollo* and the nine Muses as lively as the best Painter could draw them: and *Cardanus* says, he had one of that kind that was a true and exact picture of the Emperor *Galba*.

They say, that in the house of *Wisdom* at *Constantinople*, there is a Marble Stone, that by the very natural veins of the Stone, hath the picture of *St. John the Baptist*, with his cloathing of Camels skin expressed to the life, excepting one of his feet, which is imperfect.

It is a sign that nature hath not wrought by chance, but by particular study, and to some mysterious end, when in the same species of Stones are found the same marks and figures, like those in the fields of *Verona*, which *Leon Baptista* reports to have seen; and that they have painted upon them the image of the Chair of *Solomon*. And another black Stone, which being broken at one end, hath painted in it exactly, and

to the life, the picture of a Serpent; and that it hath the vertue to draw Serpents unto it. *Albertus Magnus* affirms to have seen 500 Serpents gotten upon a Stone of that kind, which was presented unto him.

When we meet with Stones, that represent Animals, or the limbs of them, or Plants, or other things not by superficial draught or colouring, but in bulk and substance: I believe it may arise from some petrifying liquor, which that matter has sucked into its pores, and thereby is become all Stone, and so thinks *Avicene*: but although sometimes this may be the cause thereof, yet methinks it cannot reasonably be supposed to be so always.

At the foot of the Mountains *Misnenses*, near unto the Lake of *Alsacia*, Stones are very commonly found that have embossed upon their superficies, the images of Frogs and Fishes in fine Copper. Anciently they called a sort of Stone *Conchites*, which were in all their lineaments very like unto the Cockles of the Sea; and they thought  
that

that those fish shells lying a long time in soil, where much Stones were begotten, the petrifying liquor entring into the pores of the shell converted it into Stone: and they ground this opinion upon the certainty that the Sea in old time hath overflowed the whole Territory of the City of *Magara*, where only these sort of Stones are found. But of later times all colour of reason is taken away from the forementioned conceit, by the wonderful veins of Stone, some grey, some Iron coloured, and some yellow, which are found in the high way, as one goes from *Potosi* to *Oronesis* down the Hill. There they gather Stones that have in them impressions of divers sorts of figures, so much to the life, that nothing but the author of nature it self could possibly have produced such a piece of workmanship. I have some of these Stones by me, in which you may see Cockles of all sorts, great, middle-sized, and small ones. Some of them lying upwards, and some downwards, with the smallest lineaments of those shells drawn in great perfection;  
and



and this place is in the heart of all the Country, and the most double mountainous land therein, where it were madness to imagine that ever the Sea had prevailed, and left Cockles only in this one part of it. There be also amongst these Stones the perfect resemblance of Toads and Butterflies, and stranger figures, which though I have heard from credible witnesses, yet I forbear to mention, and not to over-burden the belief of the Reader. Over-against this wonderful vein of land, on the other side of the valley of *Oroncota*, stands that famous piece of land they call *Pucara*, (which signifies in their language, fortress) it is a place the best fortified by nature of any now known in the world, being situate very high, seven leagues in compass, and all surrounded with high and inaccessible hills, only on the one side there is a small avenue after having past a very difficult ascent. In its spacious fields, on the top, there be many fine brooks of water, wood, pasture-ground, commons and wastes, very commodious for the support of humane life. CHAP.

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## CHAP. 18.

### *Of the Generation of Mettals.*

**I**T is no wonder, that learned men differ so much in their opinions, about the matter whereof Mettals are engendred, because the Author of Nature seems to have created them in that obscurity, and depth, and to have imured them with hard Rocks, on purpose, to hide their causes, and to give check to the ambition of Man.

The Philosophers, who pretend to know the causes of things, besides the first matter, (which is the first principle, not only of Mettals, but of all other bodies in the world) assign another matter remote also, which is a certain moist and unctuous exhalation, together with a portion of thick and tough Earth, from which, being mingled together, there results a matter, whereof not only Mettals, but also Stones are made: for if the driness prevail,

vail, Stones are begotten, but if the unctuous humidity be predominant, then Mettals are begotten; *Plato*, *Aristotle*, and their followers are of this opinion.

From the abundance of this pure, and shining moisture; made solid, proceeds the lustre of Mettals, in whom, of all the Elements, water is experimentally known, to be most predominant, and therefore they run, and are dissolved by the fire.

From the various temperament, and purity of the aforesaid matter, comes the divers kinds of Mettals, the most pure and fine of all which, and (as it would seem) Nature's principal intention, is Gold.

Many, to avoid difficult disputes of this nature, do hold with the vulgar; that at the Creation of the world God Almighty made the veins of Mettals in the same condition, as we now find them at this day; herein doing nature a great affront, by denying her (without reason) a productive vertue in this matter, which is allowed unto her in all other

other sublunary things; moreover, that experience in divers places hath manifested the contrary: A clear example whereof we have in *Iliwa*, an Island adjoining unto *Tuscany*, full of Iron Mines, which when they have dug as hollow, and as deep as they can, the circumjacent Earth falls in, and fills them up again; and in the space of ten or fifteen years at most, they work those Mines again, and thence draw out abundance of Mettal, which that new Earth hath been converted into: many do think that the same happens in the rich hill of *Potosi*; at the least all of us know, that the Stones, which divers years ago we have left behind us, thinking there was not Plate enough in them to make it worth our labour, we now bring home, and find abundance of Plate in them, which can be attributed to nothing, but to the perpetual generation of Silver.

The Alchymists (a name grown odious by reason of the multitude of ignorant pretenders to that Art) with more profound and practical Philosophy have anatomo-

anatomized the mixtures of nature, and reduced them from their first principles; and concerning the matter of Mettals, do discourse in the manner following: The Sun (say they) and all the Stars with their light, proper, or borrowed, continually going round the Earth, doth heat the same, and with their subtil Rays, penetrate through its veins; and we see things long burnt in the fire are converted into other terene substances, as Wood and Stones into Lime and Ashes: so in like manner this Earth calcined by the Celestial bodies, mingled and boiled with water, changes it self into another kind of species, that contains in it self something of the substance of Salt and Allum; every day we see the same effects in the lees made of Lime, Ashes, Sweat and Urine, all which by boiling, get the taste of Salt. This first matter, or foundation of the generation of Mettals is Vitriol, which is easier to believe, since we see that all of them by art, may be reduced thereunto, and the manner of reducing some of them shall be declared hereafter.

This

This Vitriol by the heat of subterranean fire, and attraction of the heavenly, sends forth two fumes or vapors; the one earthy, subtil, and unctuous, and something digested, which the Philosophers call Sulphur, because it hath the qualities thereof: the other vapor is moist, waterish, slimy, and mingled with very fine Earth; and this is the next matter, whereof Quicksilver is made. If these two vaporous exhalations do find a free and wide passage out of the Earth, then being carried up into the Region of the Air, they are converted into Comets, Clouds, Snow, Hail, Thunder, and other things that appear there.

But if the aforesaid exhalations chance to be included between hard Rocks, in strait and narrow places, whence it cannot get out, or the place be already full of Minerals, the said vapours will thicken, and be turned into those they call half Minerals.

If these fumes penetrating the Rocks, do not meet with a kind of clarified Brimston, that shines like Silver, and is some-

something like unto the Fire-stone, which the *Spaniards* call *Marcasita*, (without which no Mettal can be engendred) they will stain the Rocks with several sorts of colours, if these vapors ascending, and endeavouring to get out meet with any Stones so hard, as they cannot penetrate them, then they are converted into perpetual Springs of water; the like effect whereof we see in every common Still; but if when they pass through the Rocks they meet with, those two Juices, namely the Fire-stone, or Brimstone clarified and consolidated, as hath been said a little before, then it dissolves the said Juices, mixing it self with them, and after boiling together a convenient time, it thickens and hardens in the Mine; this is the Doctrine of *Bracesco* in his comment upon *Gestro*; but the greatest number of Alchymists do affirm the immediate matter of Mettals to be Quicksilver and Sulphur, and that from the different proportion of their mixture, and greater or lesser purification, results the difference that is found in Mettals.

CHAP.

CHAP. 19.

*The Opinion that Quicksilver and Sulphur are the matter whereof Mettals are made, is defended.*

Those that think nothing can be effected that comes not within the compass of their own capacity, a presumption very unworthy of learned men, and much diminishing their credit (who are possessed therewith) from reasons that neither convince nor are of any force to deny, hold, that it is not possible by art to change one sort of Mettal into another. It is not proper in this place to examine all the arguments of that kind, although the great connexion they have with the right knowledge of Mettals, whereof we treat, makes it necessary to handle some of them, and to make the weakness of their foundation plainly to appear.

They say, that the Alchymists are ignorant of the manner whereby Nature

ture Creates and brings Mettals to perfection ; and that it is erroneous to say they are compounded of Quicksilver and Brimston, because if it were so, there would be found in the Mines of Gold and Silver, and of other Mettals several indications and pieces of those Juices ; whereas common experience shews the contrary ; for answer thereunto, the first part of that reason imports little ; for though it be granted, it infers no more, but that those Alchemists that went about those transmutations, proceeded mechanically, and without good knowledge in the art ; but nevertheless it remains possible that such transmutations may be made.

The second part of the forementioned reason shews plainly the great rashness wherewith they affirm that which they know very little of ; for there is nothing more experimentally known concerning Mettals, then their ordinary mixture with Brimston ; and the abundance of Brimston in Minerals is an especial good sign of the richness ; a sufficient example whereof is the rose-coloured

coloured Oar of the famous mountain of *Sancta Isabella* of new *Potosi*, in the rich Province of the *Lipes*, which is almost all Plate, and engendred amongst such abundance of Brimston, that the cavities, and hollow places in the Rocks are presently all on fire, if a lighted candle touch them.

All those Oars which they call *Soroches Mulatos*, and *Negrilios*, and all such as do touch upon Antimony, or the Firestone, are certainly known to abound in Sulphur, (or Brimston) as shall be declared hereafter.

In the very same manner is Quicksilver found incorporated with the Mettals, although it be less taken notice of, because it is indiscernable in the Oar, as it comes out of the ground, and when it is put in the fire the Quicksilver fumes away, and leaves no smell behind it, as the Sulphur does, but its effects are too well experimented in the destruction of those that labour in the fumes where Oar is melted : and a few years ago we have been undeceived in this matter by the Oar of *Chalatiri*, (which is four leagues

leagues from the City, the most celebrated, and rich one in the world, *Potosi*) which being melted down, left in the furnace a bar of Silver, and also a great deal of Quicksilver, which they picked out of those ashes that were coolest, the plenty of Quicksilver there did expose it self to view; and afterwards taking more pains to work it in the ordinary manner, it produc'd as much Quicksilver as the richest Stones of *Guancavilica*, where it is possible there may be much Reliques of Plate in the great heaps of Oar, which hitherto they have refined; and I do not know whether some curious person has not already by accident found it so; when that that is already said, shall not be held sufficient to clear this point, it will bear no weight in the proof, that Mettals are not compounded of Quicksilver and Brimston, to say that these two ingredients are not met withal in the Mines; for as parts of the composition of Mettals they have already lost their proper forms, and are past into the nature of that Oar which is made up

up of them. But the most skilful artists inquiring further into the secrets of Nature, do again extract from all sorts of Mettal Quicksilver, whereof they say, they are most visibly and palpably compounded. I forbear to set down the manner to avoid the occasioning of Chymical experiments, which do more harm than good. In like manner common Quicksilver is turned into fine Plate, which is a certain proof of the possibility and truth of what has been said before, whereof there are so many eye witnesses in these Provinces, that it were a madness to disbelieve them all.

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## CHAP. 20.

*Of the efficient and formal causes of Mettals.*

BESIDES the Heavens, which as an universal cause, concurs in the Generation of all things, and particularly of Mettal; some other nearer efficient cause

cause is necessary, that having received vertue from the Planets, may work upon the proper matter of Mettals; for the qualities of the Elements alone are not sufficient, nor are appointed to produce any compounded body, but only so far as they are govern'd by some other particular vertue, as is manifestly seen in living creatures. This next cause then, or Mineral vertue, or Spirit, serves it self of the Elementary qualities, especially of heat and cold, for its instruments in the generation of Mettals; the heat mixeth uniformly the earthy and humid parts together, which is the matter whereof Mettals are made, then it boils, digests, and thickens that matter, and the cold coagulates and hardens it, and so it hath put on the form of Mettal, and is more or less perfect, according to the present disposition of that matter when the Mineral spirit began to actuate it: hereupon is grounded the opinion of *Callisthenes*, *Albertus Magnus*, and others, who say there is only one kind of perfect Mettal, which is Gold; and that all the others

others we call so are but the principles or gradations unto that: wherefore they conceive it feasible by art to reduce them to perfection, and turn them into Gold: they that oppose the possibility thereof, place the force of their arguments in proving that the several species of Mettals are compleat in themselves, and distinct one from another; and therefore that a transition of one to the other is impossible. But their reason convinceth not, and if it were granted, the inference would not follow; for we see like transmutations, and far more difficult performed both by art and nature. By art Wasps and Beetles are made of the dung of Animals; and of the Plant *Alvaca* rightly placed and order'd Scorpions are produced. Also it is notoriously known, that in *Scotland* pieces of old Ships, and of fruit that falls into the Sea turn into living Ducks; and there is no comparison between the distance of things Inanimate to Animals, and that of one Mettal to another. Besides many other things that may be brought to this purpose,

pose, it hath already been said, how some waters turn Sticks into Stones: And in the nourishment of all living Creatures, there is a continual transmutation: and in Mettals it is evidenced by the Stone *Lapis*, (or Copperas, blue or green) which (as hath been said) being dissolved in water without any other artifice turns Lead, Tin, or Iron into fine Copper. And although it may be argued with probability, that Mettals do differ specifically one from another, because the definition of Mettal agrees to every one of them, as well as unto Gold, for the particular properties that agree to every one of them. And for that we see them permanent, and without any sign, as if nature did endeavour to change one form into another, or heighten them into Gold; and for many other reasons that might be alledged; nevertheless the contrary opinion of *Calistenes* and *Albertus* are very probable; for it is not concluding that two things differ in *specie*, because the same definition agrees to both of them, unless the essential difference

ference that constitutes them such be shewn therein. As if one assert a Man and a Lion to be Animals, he cannot truly infer from thence, that they are of different species. For so *Peter* and *Paul* would be distinct in *specie*, if it were not for the differences of rational and irrational that limit the *genus*. So although the definition of Mettal do agree unto Lead and Silver, as well as unto Gold, one cannot thence rightly infer that they differ specifically, because the one may be perfect as Gold, and the other imperfect as all the other within the same species of Mettal, as a child is in respect of a man, though both have the same essential definition; the child may grow up to perfection; and become a man. The different proportions of Mettals also does something stumble one, since they are accidents that accompany its imperfection, and so are capable of being removed: and the permanency which they seem to have in their kind, proceeds 1. either from the slowness of their growth, or melioration, which comes not within the



the compass of humane observation ; when even the growth of Vegetables is inobservable, though after a great space of time we can discern them to be increased. Or 2. from the covetousness of mankind, that digs the Mettals out of the bowels of the Earth before they be come to their full maturity.

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## CHAP. 21.

### *Divers accidents of Mettals.*

**B**Eing dissolved and returning to be coagulated again, is one of the accidents of Mettals, though it be found in other things also, yet in Mettals it is after a particular manner ; the cause of this accident is the moisture, whereof it is composed, the which as it is hardened by cold, so it is dissolved by the heat of the fire, with more or less difficulty, according to the different proportion, and strong or weak mixture of it with the Earthy substance. Tin has very much moisture in it, and is very

very ill mingled with Earthy substance, and from this last comes the crackling and noise it makes between the teeth, when one bites it ; and from both proceeds its facility to melt sooner than all other Mettals : next unto it Lead melts easier than Silver, which hath need of a stronger fire, because its Earthy and humid parts are well and strongly compacted together, notwithstanding the humid doth a little exceed. Gold because it hath a better mixture of its parts, and Sulphur fix'd in its composition, or its earthy part, the purest that can be is harder to melt than Silver. Iron because the earthy part is gross and impure, and exceeds the humid, and their mixture also being ill and unequal, it burns and consumes as often as it is heat in the fire, and will not melt of it self without extraordinary great violence. Copper some do think to be a Metall very near of kin to Iron, and although it has a greater proportion of moisture in it, it is slower in melting, because its earthy part is very adust and burnt.

The

The lustre and shining of all Mettals proceeds, as it were, from one and the same cause ; for when their superficies is made plain, and smooth, or burnished, look how much the more pure and subtile the watry part of the Mettal is, so much the more lustre they give. Gold excels all other Mettals in this, as well as in many other particulars, and next it Silver. White is a colour common to divers Mettals, although Silver be most perfectly so, I cannot imagine with what sort of eyes *Cardanus* looked, when it appeared to him to be black; the cause of whitness is the moisture being terminated by the dry, fine and well digested earthy part; for if it were dirty, impure, combust, it would produce a blacker and duskeyer colour, and according to the difference of the earthy parts of Mettals herein, so do their colour come out more or less white. Gold is yellow, or red, which colour proceeds from the tincture that the Sulphur very much boil'd gives unto the Quicksilver, or moist parts, whereof it is composed, as

we

we see in all sorts of Leigh, Urine, and other liquors boild upon strong fires, that they have a red colour infused from the earthy substance, wherewith they are mingled; the colour of Copper proceeds from the same principle, although by reason of the impurity, combustion, and illmixture of its parts, it does not arrive at the colour of Gold, much less to its richness and other noble qualities.

Generally Mettals neither taste nor smell well, because of their Sulphurous quality, although Gold smells and tastes well, by reason of its most excellent temperature; or at the least, it neither smells nor tastes, ill, from the same cause also Mettals soil and black ones hands, or any other thing that touches them: but herein also Gold must be excepted, because of its incomparable purity: another propriety of Mettals is to be ductile or malleable, which proceeds from the moisture, being inclosed in the dry parts, which upon the stroke of the hammer gives way, and changes place, from whence pro-

proceeds the enlarging of the Mettals. Of all Mettals, Gold is the most ductile, next Silver, then fine Copper, Iron, Tin, Lead, &c. Mettals burn and are consumed in the fire from unctuous Sulphur, or Earthy parts; as on the contrary, those parts they have of moisture or Quicksilver does defend and preserve them from it: the parts of Gold and Silver are so pure and strongly compacted together, so that the Earthy part defends the moist from evaporating, and the moisture protects the Earthy part from burning, and so they endure the fire without any diminution or corruption. Other Mettals waste in the fire for want of perfection and compactedness of the parts whereof they are composed.

CHAP.

CHAP. 22.

*Of the number of Mettals, and the Places wherein they are Engendred.*

**T**Hose who are vainly curious attributing unto the Stars and Planets particular influence and dominion over all sublunary things, do appropriate the production of precious Stones to the superintendency of the fixed Stars, who seem to imitate them, not only in their brightness and lustre wherewith they twinkle; but principally in the purity and permanency of their substance; as on the contrary, for the instability and alteration of form in Mettals, being sometimes liquid, other times coagulated, they assign them to the particular government of the Planets, (who from the variety of their motions are called wandring Stars) moreover they assign the number, names, and colours of the Planets unto Mettals, calling Gold, the Sun; Silver, the Moon; Copper, Venus; Iron,

Iron, Mars; Lead, Saturn; Quicksilver, Mercury; although because this last is not a Mettal, some instead thereof call Electrum Mercury, (which is a natural mixture of Gold and Silver) which was heretofore esteem'd the most precious of all Mettals; but this subordination and application is uncertain, as is also the conceit that Mettals are but seven in number; whereas it is very probable, that in the bowels of the Earth there be more sorts than we yet know. A few years ago in the mountains of *Sudnos* in *Bohemia*, was found a Mettal which they call *Bissamuto*, which is a Mettal between Tin and Lead, and yet distinct from them both: there are but few that know of it, and 'tis very possible more Mettals also may have escaped the notice of the generality. And if one should admit the subordination, and resemblance between Mettals and the Planets, modern experience, by excellent Telescopes has discover'd, that they are more than seven. *Galileo de Galiles* has written a Treatise of the *Satelites* of *Jupiter*, where one may find

find curious observations of the number and motion of those new Planets.

Reason and experience teacheth, that the most proper place for the generation of Mettals is the veins of the Earth, which do run through its great body as principal receptacles of its permanent humidity, proportionable to its solidity and hardness, as blood is in the bodies of Animals. The Rocks between which Mettals commonly are engendred, which they call *Caxas*, (or *Chests*) serve for Conduits, where subterranean and Celestial heat meet and unite the one with the other, stirring up vapours, mingling and purifying the matter of which Mettals are made, without giving it time to divert and dissipate into several places; that which communicates between Chest and Chest is called a Vein; and that which time has moulder'd off, or the Rains carried away from the matter that fills it, is found scatter'd up and down the mountains broken, and tumbled away by themselves, which are the Stones of Mettal; those that understand this art best

best believe that the Gold that is found in the Sands of Rivers has the like Original, that it is not engendred in the Sand, as divers will have it, but in veins of the Earth carried from thence by rains unto the Brooks ; yet be this how it will, (although what has been said is the more natural and ordinary way of proceeding) oftentimes it happens, that in some parts or bits of land they find that which is called *Creoderos*, where Mettals are engendred out of Veins by the disposition of matter, and the powerfulness of the Mineral vertue which there meet together.

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### CHAP. 23.

*The manner how to find out the Veins of Mettals.*

**T**He Veins of Mettals are discovered either by art or fortune. Violent currents of water wash off the first coat of the Earth, and so leave the veins of Mettal naked to the eye, if there be  
any

any there: great storms of wind many times tear Trees up by the roots, and with them some Stones of the Mettal of that place: the same effect also hath the falling of pieces of Cliffs and Rocks caus'd either by thunder-time, or great rains, and wash away the cement that should hold them together. Oftentimes rich veins of Mettal have been discovered by the Plough, whereof *Justin* makes mention of Gold that was found in *Spain*. In my own ground, a quarter of a league from *Chauquiscaca*, ploughing upon the ridge of a hill, I discover'd a vein of *Soroches*, and 'tis very probable that the like happens in divers other parts of these Provinces, which are so fertile of Minerals; & that the ignorance of the Plough-men hath been the cause they have not profited by the riches which fortune has put into their hands. *Lucretio* in elegant Verses hath set forth, how that the mountains being set on fire, either on purpose, or by chance, discovered the nature of Mettals unto the world, melting them, and making them to run out

of the Rocks wherein they lay concealed, into the form that now they are known. By the same accident also have been, and may be hereafter, because of discovering the veins of Metals, which the Histories of *Spain* confirm unto us in the burning of the *Pere-nean* mountains; and much lesser violences than those have been sufficient, when fortune has had a mind to distribute Riches to her favourites. A man riding a horse-back over the Country in *Gosolaria*, by the soil broken with the small force of his horses feet, discover'd a very rich Mine, as *Agricola* reports. An *Indian* servant of mine pulling up by the roots some bushes of *Tola*, a sort of wood, ordinary in this Country, together with the roots pluck'd up a rich Stone of Mettal, which was Silver, white, and in dust; this was half a league from the Mines of *St. Christopher de Achacalle*; he brought me home the Stone, whereby I discovered the vein of Silver, and shew'd the place unto the Officers of the Mines.

When

When the rich Mines of *Tuno*, in the Province of *Carangas*, began to be famous for the riches, abundance of Soldiers flocked down thither; some of them being very poor, fortuning to have no share in the Veins that were already discovered, and conferring together how they should get their living, saith one of them; if God please, here we shall get enough to maintain us; together with which he kick'd the ground with his foot, and under that small deal of Earth, which so slight a blow could turn up, they saw a piece of white silver, which they took up, with incredible admiration, and therewith suppli'd their present occasions, without any further labour, (the piece of Silver being about the bigness of *Botijuela*) and afterwards the vein of Silver in dust, which was found underneath that Stone (or rather pure Silver) yielded much riches both to them and others. That mine is called the Poor mans Mine, and is the richest of all that were in

*Botijuela is a Spanish vessel, which contains about a Gallon.*

G 2

that

that famous farm. The Mine of *St. Christophers* in the *Lipes* was also found out by chance: amongst the Rocks thereof breed great store of *Biscaches*, a little creature about the bigness of a Hare, (game very ordinary, and of good nourishment in these parts) one of these being kill'd with a Gun, the man that shot her, found her dead upon a rich [*farellon*] of Silver, and called this Vein, *Neustra Seniors de la Candelaria descubredora*, afterwards they registred divers other Mines, which made that Farm so deservedly famous, as that abundance of *Spaniards* resorted thither, and that it is reckoned the third best Mine in all the *Indies*, namely, next unto *Potosi* and *Oruro*.

CHAP.

## CHAP. 24.

*Besides those Veins of Mettal, which do discover themselves, or are found by chance, as has been said before, there be others procured by the Art and Industry of Man.*

THE colour of the superficial Earth is no small indication, whether or no there be Mettal in the bowels of it, as has been said in the first Chapter of this Treatise, and hath been found by experience in all the Mines hitherto discovered in this Kingdom, the superficial Earth of them being of a far different aspect from other Earth, even to the sight of those who are very little vers'd in this matter. There is no certain infallible rule by the colour of the Earth, to judge what kind of Mettal it contains, that being only to be known by experience and ensaying, as we see in Gold, which is ordinarily found in red Earth, or yellow tinctur'd with red,

G 3

like

like unto a hard burnt Brick: nevertheless in the Mines of *Oruro* and *Chianza* the Veins of it are found in white Chalk; in these Provinces the Earth of other Minerals most commonly is reddish, of the colour of Wheat, after the pattern of *Potosi*, (their first copy) of the same colour is that of *Seapi*, *Perira*, and others in the *Lipes*, which produce Copper; and although sometimes the Earth is found of grey, green, and red colour; yet generally it is of the colour of Wheat. The very same kind of Earth likewise is found in the Lead Mines; so that the true knowledge of what species the Mettal is depends upon the ensaying of the Oar.

The veins of Mettal are found sometimes above ground in great Stones, which being broken, the Miner discerns that they contain Mettal and ensays them, and sinks his Mine there, if he finds encouragement, and that it is like to be profitable; but if the veins be covered, they hunt them out, after this manner, *viz.* taking in their hands a sort of Mattock, which hath a Steel point

point at one end to dig withal, and a blunt head at the other end to break Stones withal; they go to the hollows of the mountains, where the downfall of the rains descends, or to some other part of the skirts of the mountains, and there observe what Stones they meet withal, and break in pieces those that seem to have any Mettal in them: whereof they find many times both midling sort of Stones, and small ones also of Mettal. Then they consider the situation of that place, and whence those Stones can tumble, which of necessity must be from higher ground, and follow the track of these Stones up the hill, as long as they can find any of them, and when they are gotten so high, that no more of these Stones appear, it is a certain sign, that there or thereabouts begins the Vein, there then they break Earth, and run their Mines according as the veins of Mettal, which they meet withal guide them.

The gushing out of water in the files of the hills are very good signs, that the veins of Mettal are near, because



commonly they are the conduit-pipes of them.

When Trees, Bushes, and other Plants, and Weeds of the same sort, are found to run along in rows, as if they were planted by a line, oftentimes it proves, that a vein of Mettal runs underneath them.

The Plants that grow over the veins of Mettals, are not of so great a growth, nor so strong a colour, as others of that kind, because the exhalations, which come from the veins blast them and hinder their perfection; for the same reason also, the morning dew, and the snow which falls is gone sooner from those mountains that have Mines, than from those that have none, and from the place where the veins run, sooner than from other places of the same mountain.

CHAP.

## CHAP. 25.

*Of the several sorts of Veins, and how to find them out.*

Although the word Vein be a general term given to all places, that contain Mettal, yet in the particular speech of the Miners it is applied to those Veins that run down perpendicularly, or sloping; (which is more usual) from the Horizon, and those veins which run parallel in the ground, without any considerable depression from the Horizon, they call *Manto*, (a word which signifies a cloak or blanket, which the women in *Spain* throw over their heads and shoulders.) Both these sorts of veins are usually found, although most commonly the Mines that are wrought are those that run downwards; those veins which are found seldomest of all, are those the *Spaniards* call *Sombreros* (which in their language signifies a Hat) or a heaped Mine,

Mine, which is where Mettal is found in a lump together, in what quantity or distance soever, from which no veins run, either downward or sideways.

In what vertical plain the veins of Mettals generally run, hath been curiously observed by all the Miners of *Europe*, as being certain signs of the greater or lesser riches, and abundance of the Mine, esteeming principally those veins that run from East to West, or thereabouts, in the northern part of the mountain; next they esteemed those best (in the northern part of the mountain) that run North and South, or thereabouts. They gave the third place of estimation to those veins which run North and South, on the Eastern side of the mountains, and valued those little or nothing at all which ran the contrary way. Whether the veins do run East or West, is easily seen by the grain of the Stones in the joyning of the Stones together, or chests that contain the Mettal, because that runs towards the part where the Mine ends; a thing easie to be observed in the pieces of the  
Rocks

Rocks that are found above the superficies of the Earth; and those within the bowels of it, run after the same manner: other such like signs they give us, whereby to know those Brooks or Rivers that have Gold in them, but with less reason, because the Gold is not engendred there, but in the veins of the mountains, from whence time and the downfalls of water have worn it away; but without disparaging the judgement of those that have thought as above-said, and have written to that purpose; I say that for the most part in the Mines of *Europe*, and of these parts, experience hath shewed the contrary, which I foresee they will answer, by saying, that oftentimes an effect is produced contrary to expectation, and that these have their exceptions as well as other rules; nevertheless if it be lawful for us in this other world, and opposite Climate, to make new rules from the experiences in the rich Mines of *Potosi*; I should assign the first place of riches, and abundance to those veins that run North and South upon the northern side  
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of the mountain ; which point of the Compass, with a very little declination Westward, the four principal Mines of this mountain observe ; namely, the Mine of *Centeno*, which was the *Descubridora* ; the Rich mine ; the Tin mine ; and the mine of *Mendieta* : the second place I should give to them, that run North and South, on the South side of the hills. A point of the Compass parallel, whereunto run the best veins of the second famous Mine of this Kingdom, which hath its name from the famous City of St. Philip of *Austria* called *Oruro*, which in the richness of its veins, abundance of Mettals, depth of its Mines, and great concourse of inhabitants, deservedly stands in competition with the grandeur of *Potosi*.

In divers places very rich veins of Mettal run East and West, and also to several other points of the Compass ; so that the best rule to go by in this matter, is to follow the Mettal, as it discovers it self, and as long as one gains thereby, or at least saves himself, it is worth the following on, because being sure to  
lose

lose nothing one hath, the vein will lead him to great riches ; and if the vein be large, and have any signs of Gold or Silver in it, although for the present it doth not quit the cost, men go on couragiously in the working of it, having such certain hopes of gaining great profit ; this hath been confirmed by experience in all the Mines of these Provinces ; a fresh instance whereof we have in the rich Mine of *Chocain*, ( where for the instruction and encouragement of Miners ) after having followed its veins forty years, with very little profit, at length they have met with the extravagant riches, which all of us in this Kingdom have heard and seen. If the veins of Mettal be very small they must be extream rich to be worth the following : if the Mettal be found clinging about Stones, and likewise in the hollows of those Stones, it be found in grains like corns of Gunpowder, ( being that which the *Spaniards* call *Plomo* ) and is Silver unrefin'd, although these grains be but few, and therest of the Mettal have no Silver in  
it,

it, nevertheless it is a sign of the riches of the vein, when it meets with more moisture. As it fell out in that great Mine of St. *Christopher* of the *Lipes*, which they call the Poor man's Treasure, if as they dig forwards they meet with more abundance of those grains, *de Plomo*, it is a sign that the rich Oar is very near. To find *Chrisocola*, *Herrumbre*, *Oropimente* or *Sandaraca* in the Mines, or iron-colour'd earth, next to the Stones that inclose the Oar, or Fullers-earth between those Stones, are very good tokens of the richness of the Mine; it is no ill sign also to meet with dry Earth, if it be yellow, red, black, or any other extraordinary colour, and 'tis the better when there is some shew of Lead mixt with it: Chalky-ground is very promising, and *Agricola* doth judge it a good sign to meet with Sand in the Mines, if it be exceeding fine, and very ill to meet with Earth full of little Flints, if it hold long, without changing into another soil.

CHAP.

## CHAP. 26.

*Of Mettals in particular, and first of Gold.*

**T**He most perfect of all Inanimate bodies, and the most esteemed of all Mettals is Gold, universally known, and coveted by all people. It is made of the same matter, and in the same manner as other Mettals are, (as hath been already shewn) but of parts so pure and perfect, and so well compacted together by decoction, that its substance is, as it were, incorruptible, being out of the power of any of the Elements to be corrupted or destroyed. The fire that consumes all other Mettals, only makes Gold more pure: The air and water diminish not its lustre, nor can Earth make it rust or waste. By the nobleness of its substance, it hath most deservedly obtained that estimation, which the world gives it, and the natural vertue which flows from the admirable

mirable equality of its composition, is the best medicine against melancholy, and the greatest cordial to the hearts of men, which perpetually run after this avaritious Mettal, as the Needle doth after the Loadstone. The qualities that it hath in common with other Mettals, have been briefly touched in Chapter 21. The vertue ascribed to *Aurum potable* to preserve a body perpetually in youthfulness, without infirmity; together with the receipt of making thereof, depends upon the credit of those Authors, who have written concerning the same. Many writers upon this subject relate the names of divers Countries, Mountains, and Rivers, famous for the production of Gold, but my design is not to be over-large; and therefore I not only forbear to translate what other men have written, but also to treat of the greatest part of the Mines in this new world, even those of divers of the Provinces of *Peru*; and only apply my self to give your Lordship a short account of those which are found in the Royal *audiencia de los*

*Charcas*,

*Charcas*, the government whereof is worthily committed unto the care of your Lordship. Every body knows the name of *Carabaya* for being a Country stored with plenty of the finest Gold, (as fine as the finest Gold of *Arabia*) it is of the *ley* of 23 *Corrats*; and three grains; and although an incredible quantity thereof hath been, and daily is gotten thence, yet now they begin to work again a-fresh, and follow the veins of it under ground, whereas hitherto they have only gathered up the fragments of it, which were washed off by the rains. The Province of *Larecaja* borders upon *Carabaya*, and abounds with Gold, which in divers Brooks of that Country, is found in form and colour like unto small shot, which being melted, and its outward coat and mixture consum'd away, becomes of a red colour; he that found this first did not know it to be Gold, until a friend of his, unto whom I discovered it, told him so.

Next unto *Larecaja* joyns *Tipuane*, a Country inhabited by savage Indians,

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with

with whom we have had wars, and made incursions upon them, ever since the building of the City *de la Paz*, where I was present, and is now above twenty years ago: this Country is so largely reported to be rich in Gold, that it were incredible, unless so many eye-witnesses had affirmed it: the proper name of this City *de la Paz*, is *Chaquiyapu*, which we corruptly call *Chaquibabo*, which in the language of this Country, is as much as to say *Chacra*, or the Farm of Gold; it hath abundance of Mines in it, that were wrought in the time of the *Incas*; it is a soil generally known to be fertile of Mettals; and in the time of the rains the Boys often pick up Gold in the streets in small bits, like the kernels of apples, especially in that street that goes down to the River, by the convent of the *Predicadores*; and in the valley of *Coroico*, and others, which they call *andes de Chaquibabo*, in the cliffs of the Rocks Gold is found of a grey colour on the outside, like unto Lead. The Silver Mines of the famous Town of *St. Philip*

of

of *Austria*; *Oruro*, are encompassed round about with other hills, in which there are many rich veins of pure Gold, which have been wrought heretofore; at present there is only one wrought, and that by my perswasion: upon the ridge of that mountain, that runs over the Silver-mills, which they call *de las Sepolturas*, the Oar whereof being well ground to powder, and ensayed by Quicksilver, yields a considerable profit, they have not followed any more of the veins, for want of industry, their common trade being getting of Silver, (or which I rather believe) because in those veins they have already wrought, they have not gotten so much Gold as they expected; although that ought not to discourage them, because it may reasonably be supposed, that where so many veins of Gold are, there be some of them very rich, if they have the good fortune to light upon them, the same which daily experience hath shewed in the Mines of Silver.

The bounds of *Chayanta* are full of veins of Gold, and have some ancient

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Mines

Mines already sunk in them, and in the Sands of its River, which is called, *el Rio grande*, kernels of Gold are found, and in the River of *Tinguepaya*, seven leagues from this City of *Potosi*, they have found Gold also.

In the Confines of *Paccha*, *Chuqui-chuqui*, and *Presto*, near unto the City of *Chuquisaca*, there be many Caves, out of which they have gotten some shew of Gold: the like also is found from the River *Sopachay*, up unto the *Chiriguanes*, where it is held for certain, that there be rich Mines of Gold, which the *Indians* have this year offered to discover unto us.

The River of *St. Juan*, which runs at the bottom of the Province of the *Chiquas*, where it joyns with the *Calchaguies*, is very full of Gold; in *Esmeraca*, and *Chillio*, of the same Province the ancient Gold Mines are yet to be seen: there is one hill of the *Lipes*, which is near unto *Colcha*, which hath Gold in it: there is a Mine also three leagues from this Town, in a place they call *Abitaris*, which in the *Lipean* language

guage is as much as to say the Mine of Gold. I believe for a certain also, that there is Gold in the Province of *Atacama*, because of the abundance of fine *Lapis Lazuli*, which is found there, in which Gold is engendred.

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## CHAP. 27.

### *Of Silver, and the Mines thereof.*

Silver is the most perfect of all Metals, except Gold, whereunto it comes so near, as to want nothing but the colour; and therefore those that most of all oppose the opinion of the transmutation of Mettals one into another, do yet hold it possible to turn Silver into Gold, because the colour only being wanting, the fire, and artificial concoctions can supply that, whereof there be many experiments: from the good mixture, and fineness of its parts, proceeds its enduring the fire with very little waste, as also its being tough and malleable, and endures the drawing out

into very thin leaves, and small wyre; if it were not a common trade to do it, it would not be believed to be possible, that an ounce of Silver should be drawn out into 1400 yards of wyre; and it is yet more admirable, that all that shall be made gilt wyre, with only six grains of Gold; so that although Silver can be extended to admiration, yet Gold is a hundred times more ductile than it; one ounce of Gold suffering its self to be beaten to that thinness, as to overspread ten *Hanegadas* of land.

In the Mines oftentimes Silver is found white, and pure, and like, as it were, wyre woven one within the other between the Rocks, which the *Spaniards* call *Metal Machacada*, such as is found in that Mine they call the *Turks*, in the Province of *Carangas*: in *Choquepina* a Mine of the *Ingas*, two leagues from *Berenguela*, in the Province of the *Pacages*: in the mountain that I discovered and registred, half a league from the works of *St. Christopher*, in the Province of the *Lipes*: in *Yacu*, of the Province of the *Charcas*: (which in

in the middle of its Oar yields rich Copper) there was found last year a Stone coated over with white Silver, the Metall contained within, being yellow, like unto the colour of a Lion. And in the rich Mine of *Chocaya*, in the Province of the *Chichas*, in the richest Stones of that Oar they have found much Silver, like wyre woven together as aforesaid; and in all the Mines of these Provinces, at some time or other Stones have been found, made into Silver wyre as aforesaid, and wedges of pure Silver; but no other Mine hath produced the like unto that of *St. Christopher* in *Oruro*, which besides the leaves of fine Silver, that are found between the Stones, produceth fine Silver also in small dust mingled with the mould, or earth, that is dug there, which may be gotten together without any more trouble than washing, in the same manner as they use the Gold that is found in sand; but most commonly in all Mines Silver is found incorporated with the Stones, and is scarce discernable, nor to be known, but by



men of good experience. In the circuit of the *Charcas*, there is such abundance of Silver Mines, that they alone, if there were no other in the world, were sufficient to fill it with riches: in the middle of this jurisdiction stands the wonderful mountains of *Potosi*, of whose treasure all Nations of the world have liberally participated; the excellencies whereof, & of that imperial City, whereunto it hath given the name, do so much surmount any other thing in the old, or new world, that they very well deserve a particular history to eternize their fame: it is surrounded (for the most part) with abundance of rich Mines, that of *Porco* is the famous Mine of the *Ingas*, and the first, out of which the *Spaniards* dug any Silver; those very ancient Mines of *Andacava* are admired by all Miners for their vast depth, and admirable contrivance, and plenty of Oar, which is such as promises continual employment, for half the *Indians* of this Kingdom. Those of *Tabacco Nunio* are near unto a Lake called by the same name, have such wonderful

and

and costly engines appertaining to them, that the building of them hath consumed a great part of the treasure of this Kingdom: that Lake contains so much water, as would make a running river all the year long, with which there goes day and night a hundred Silver Mills, which grind the Oar which is gotten from its own banks. Within the bounds of *Potosi* also are the Mines of *Guariguare*, *Caricari*, *Piquiza*, *la vera Cruz*, *Sipoto*, and many others.

In the *Lipes* there be Farms of Mines of greater fame, namely that of *St. Isabel* of new *Potosi*, the name whereof doth not more predicate its beauty, than doth the amenity of the mountain, and the richness of the Oar that is found there. *La Trinidad* is a wonderfull rich Mine, there be also the Mines of *Esmoruco*, *el Bonete*, (which they call so, because the top of the mountain is like a Bonnet.)

*Xanquegua*, the new world which hath been discovered in my time, yields very rich veins of Metall; namely, *Abilcha*, *todos Santos*, *Osqoque*, *St. Christoval*, and

*Roval, de Achocalia, Sabalcha, Montes claros, and many others. In the Chicla are St. Vincent, Tatafi, Monserrat, Esmeraca, Tasna, Sbina, Chorolque, old and new Chocaya, which to the shame and astonishment of the Miners, hath been now last of all found out, and is one of the richest in all Peru.*

## CHAP. 28.

*Continuing the discourse of the last Chapter, touching the Mines of Silver.*

**T**HE Province of the *Charcas*, besides the rich mountain of *Potosi*, ( which alone was sufficient to eternize its name ) and the other Mines aforesaid, that are round about it hath also the Mines of *Taco*, (or the mountain of miracles) those of *St. Pedro de buena vista*, and those of *Malcocota*: there is Silver Oar also found near unto *Cayanta*, and also in *Paccha*, and *Tarabuco*, not far from *Chuquisaca*, and in other places. Within the Jurisdiction of *Panna*, stand

stand the three great mountains, *St. Christoval, Pie de Gallo, and la Flamenca*, which together make up those Mines, which they call of *Oruro*, that famous Town, which is near unto them. In the neighbourhood of *Oruro* also are the Mines of *Avicaya, Berenguela, Cica-cica, la Hoya, y Colloquiri*, which although it is a Mine of Tin, yet now and then in following the veins thereof they meet with rich Oar of Silver, which they call *Lipta*: In the Province of the *Pacages* is the rich Mine of *Berenguela*, with the mountains of *Santa, Juana, Tampaya*, and others, and in the bounds of the *City de la Paz*, there are the Mines of *Choquepina, Pacocava, Tiaguanaco*, and divers others; briefly all these Provinces are nothing but a continued Mine, and notwithstanding so great a number of Mines are opened at this day, yet it is certain, that there be many more known unto the *Indians*, which they craftily have concealed from us till this present.

There is a certain tradition in this Country of an incomparable rich Mine belong-

belonging to the Village of *Chaqui*, four leagues from this Imperial City, although at present the sight of it is not known, divers *Indians* having killed themselves out of obstinacy, that they might not discover it.

There goes no less fame of the Mine, which they call *de los Encomenderos* in the Province of the *Lipes*, which name was given it divers years ago by the *Indians*, who getting a great quantity of Silver out of that Mine, gave that Treasure unto two *Spaniards*, whom they dispatched away into *Spain*, as their Agents, (they were two brothers of the surname of *Tapias*) whereupon this rich Province was incorporated into the Crown. Whilest I was Curate of this place, I spoke with many of the Country people, that told me, they had helped to load, and conduct that riches unto the Port of *Arica*, where it was put on Shipboard: it is agreed on all hands, that the abovesaid report is true, although at present that Mine remains undiscovered, which I do not at all wonder at, when I consider, that all  
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the Mines that are wrought in that Province have been found out, and first taken say of, by the *Spaniards* themselves, without lighting upon any one ancient work of the *Indians*; whereof no doubt there were formerly very rich ones, as appears by the choice Stones, and pieces of Oar, which *Indians* have given me, without discovering whence they had them: and the very streets of the Town, when I was Curate there, were full of small grains of rich Oar, which I swept up, and made profit of. In the plains of *Julloma* in the *Pacages*, the *Indians* anciently have wrought Mines, which at this day remain undiscovered. It hath been a vast quantity of small pieces of Plate, which they call *Corriente*, that the *Spaniards* have bought up, among this people, and I my self have gotten there some of the remainders of that sort of Silver: these grounds, together with the colour and beauty of the mountains, makes one rationally to suspect that Country to be fertile of rich Metall: but it is more certain, that there are rich Mines in the  
Parish

Parish of *Caquingora*, in the same Province of the *Pacages*, because I have seen Stones of rich Oar picked out of the paving of their streets, and the walls of their houses. The same report goes also of divers of the neighbour Towns and a constant fame, that in the time of the *Ingas*, each of the parties had their particular Mines

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## CHAP. 29.

### *Of Copper, and the Mines thereof.*

**T**He Sulphureous parts do predominate in the composition of Copper, and from their distempered heat rises the fiery colour of that Mettal; when it is melted it smells more of Brimston than any other Mettal; and because it is over-burnt in its composition, therefore it is less subject to injury or corruption, by the air, earth, or water; as for the same reason, Coals are not subject to such like accidents: they use Copper about engines of long duration, because

because it never rusteth as Steel and Iron doth; and for the same reason it was highly esteemed by the Ancients, who made the bolts and nails of their Ships, their weapons, and other instruments of this Mettal, which also we found in use among the Natives of this Kingdom.

Copper is engendred in mineral Stones of divers colours, although ever the most predominant colour is blew or green: it is engendred in the same places with Gold and Silver, and oftentimes in following a vein of pure Copper they have met with a nest of the finest Gold; but it is more familiar to have its veins change into Silver; and those veins of Copper that make any shew above ground, commonly prove very rich as they are dug deeper, and consequently are more moist. The Mine of *Osloque* in the *Lipes*, was at the top in a manner all Copper; and every spades depth as they dug downwards the Oar grew more rich in Silver, until it came to be pure Silver, at the bottom of the Mine, where the water increa-

increasing to a mans height hindred them from prosecuting its farther riches: what hath been said is a token of the affinity between the matter of composition of these Mettals, and that the greater or lesser purification is the only difference between them.

There are many Mines of Copper in these Provinces, and the bottoms of all the Mine whereout Silver hath been taken, have been found to yield great store of it, which for the colour sake they call *Negrillo*: so that how many Silver Mines there are, so many Mines there be whence Copper may be gotten also; besides there be Mines of Copper only from the very superficies of the Earth downwards; there be divers ridges of hills about *Potosi*, that are full of these kind of Mines, although most of the Copper that is wrought in this Town hath been gotten from the Farm *de las Laganillas*; and now is gotten from that of *Yura*. In the *Lipes* there is a very great old work of Copper in the mountain *Scapi*, two leagues from *Chuyca*: there is another also, wherein there

there is Copper-mettal like wyre woven. A league from *Sabalcha*, in the high way to *Colcha*; and notwithstanding it is found in many parts of this Province, yet no where is the success so prosperous, as in the mountain of *Pereira* and its confines, until you come to *Guatacondo*.

In *Atachama* there are very large veins of Copper, some of them run unto the Sea side, and tumble down the cliffs in great massy lumps of this Mettal. In the *Chicas*, where the soil is not taken up with Silver, 'tis full of Copper mines; and not far from *Esmoraca*, they get of this Mettal, woven like wyre, (or *Machacado*, as the *Spaniards* call it) there is also very rich Copper in *Oroncota*, and in the top of the mountains of *Tarabaco* many Pits and Copper-works of the ancients are to be seen. It is found likewise in all the rest of the *Charcas*, particularly in the confines of *Maoha*, *Copoata*, and *Chayanta*; and in *Paria* near unto *Oruro*. And in the Province of *Carangas*, the hills adjoyning to the Silver mine, called

led *el Turco*, are full of Copper. Near unto *Curaguara de Palages*, there be many ancient works of the *Indians*, whence they get Copper *Machacado*, (or like wyer woven together.) In the high way between *Potosi* and *Fulloma*, one sees many veins of Copper. Also a league from *Callapa*, in the road that goes to the City *Paz*, one crosses some large veins of it. Not far from *Caquingora* there be divers stately works, and much Copper *Machacado* upon a white chalk. Within less than half a league from *Fulloma*, near unto the high way that goes to *Calacoto*, in hills of dry clay, I found branches or small veins of pure Copper, like unto fine Gold, whereof I got a great quantity of that which was scattered about above ground. There is of this mettall *Machacado* in *Choquepina*, near unto *Berenguela de Pacages*; and several works and virgin veins in the high way from *Calacoto* to *Potosi*, half a league before one arrives there, and in like manner over all the rest of this Province.

## CHAP. 30.

## Of Iron.

**I**Ron, although it is not the most precious, yet it is the most necessary of all Mettals for the use of man; notwithstanding it may be disputed, whether the good or hurt it hath done in the world, be the greater; nature hath made it so hard, by putting over much earthy parts or fixed Sulphur in its composition, although it hath also a sufficient portion of humidity, or Quicksilver, so that in the first place it will not melt without a very violent heat; and in the next place, being struck with a Hammer, it doth not break into small pieces, as hard Stones do, but receives impression, thereby dilating and extending it self. It is a Mettal cold, and dry, but more porous than others, and therefore weighs less, and is more subject to rust, and decay in the wet: especially in Salt-water, which penetrates

trates most: it wastes in the fire also every time it is heat, falling off in scales, because it wants humidity proportionable to its earthiness. If when it is red hot it be quenched in cold water, it will become very brittle, because the heat being pent up in the heart of the Iron by the ambient cold, doth there prey upon, and consume part of the natural moisture, which made it tough, and malleable.

These fertile Provinces of all other sorts of Mettal are not destitute of this also, though none employ their labours to seek it out, or work it; because here is such abundance of Silver, about which they are industrious to greater profit, and in truck for it, they buy abundance of that excellent Iron of *Biscay*: this proceeding is not to be wondered at, when one considers the abundance of Copperas, Allum, Quicksilver, and other Minerals, which is yearly brought from *Spain* to these *Indies*, where the same commodities may be gotten in such abundance, as were sufficient to supply, not only the occasions

ons of these Kingdoms, but also of *Spain* its self, and of all the world beside.

In the valley of *Oroncota*, there is a great deal of Iron, the people of the Country, being encourag'd by the looks of the place, and fair appearance of the Oar they found, followed a large vein of Mettal, hoping that it was Silver, and brought me some of the Oar to ensay it, the which I did, and undeceived them, by telling them it was Iron: the same has happened in other veins at the rise of the River *Plicomayo*, five leagues from the City *de la Plata*, although that Oar has some Copper mingled with it, and is not pure Iron as that of *Oroncota* is.

Adjoyning to the *Ancoraymes*, a Town in the Province of *Omasuyo*, there be noble Mines wrought formerly by the *Ingas*, of so great fame, that it is very well worth ones making a journey purposely to see them: the Oar is very heavy, and hard, and of a dark colour, although there be found together with it much Oar, that sparkles and shines. If you rub pieces of the dark Oar together,

gether, it produceth a very fine blood colour, like that of the *Hemmotites*, to whose species undoubtedly it belongs, and is full of Iron, as I have proved by many ensays; it is possible the *Indians* followed veins of richer Mettal in these Mines, which hitherto we have not met withal, or because Iron was not in use amongst them: they dug this Oar to fit it to their Guns, Stone-bows, and Slings; it being not inferior in weight or hardness to our Iron bullets, they did make use of these in their wars, and called them *Higuayes*.

In *Oruro*, hard by the Silver Mine of *Santa Brigida*, in the hollow between the hills, there is a vein of Iron, of which out of curiosity, and for example only, when I was in that Town, I saw several Iron Keys made: the Mettal which they call *Chumbri*, taken out of the Mine of *Chocaya* in this mountain of *Potosi*, and others, have much Iron in them: and doubtless there is abundance of Iron in many other parts of this Kingdom, although the people do not regard, or seek after it, nor do the Miners

ners in their ordinary ensays meddle with any thing, but the knowledge of Gold and Silver.

## CHAP. 31.

### *Of Lead.*

**L**ead is a very common, and known Mettal, there is no Silver Mine, where much of it is not found; and there is scarcely any other Oar but has some mixture of Lead in it. Nature hath qualified it with abundance of humidity, that it might be serviceable in the melting of Gold, and Silver, which without the help of Lead burn away, and consume in the fire, before they arrive to their full perfection. By reason of its moisture it doth easily evaporate in the fire, and melts; carrying along with it whatsoever is not Gold or Silver, and therefore its self is very easie to be refin'd: it is likest unto Gold in weight, and unto Silver in colour, being melted together with them.



It not only facilitates the founding, and refines them, but separates the Copper from them, as shall hereafter in its place be shewn ; and therefore is the most necessary of all things, in the art of founding of Mettals, the whiteness of it shews the abundance of humidity, or impure Quicksilver, whereof it is composed, which the Chymists in several manner of ways do easily separate from it.

It neither diminisheth nor corrupts by the air or water like Iron, but rather increaseth both in weight and quantity, as very good Authors do affirm, notwithstanding others do say, that sheets of Lead exposed to the weather do waste and consume, and have been the ruine of many goodly buildings covered therewith. It is rarely found mingled with Gold, most commonly with Silver, and sometimes with Copper. The Oar in which Lead is engendred is called in this Country *Soroches*, which for the most part is black, full of holes, and sparkling ; other pieces of it they call *Muertos*, because it doth not sparkle,

nor

nor is spongy ; others they call *Oques*, which in the language of this Country is as much as to say *Fraylescos*, because it is of the colour of a Friars coat : there hath been no Silver Mine discovered in all this Kingdom, wherein some Lead has not been found, in which regard it is needless to enumerate the several places that afford this Mettal, although most of the Mines in the *Chicas* have abounded therein, and therefore it is that they have founded so much Mettal in this Province. The Mines of *Andacava* are Lead and Silver also, but because that Oar is not proper to be separated by Quicksilver, and there is not wood enough near the place to melt it down ; this Mine, which in my opinion is one of the richest in all the *Indies*, continues hitherunto yielding but a very small profit. Below the mountain of *Potosi*, as far as its shadow reacheth in that part called *Desibicos*, there be many veins of Lead, with a very little Silver mixt in it ; the like also there is within the shadow of *St. Christoval de Oruro*.

## CHAP. 32.

*Of Tin.*

**T**He Mettal which we call Tin, divers call white Lead; particularly they give it this name, that separate Silver, and Copper, in which operation some Tin comes forth, as shall be said in its place, which is known by its whiteness, and the noise it makes when one either bites or breaks it. Common Tin is begotten from the same principles as Lead is, but more fine and better purified, whence it becomes more hard and white, although from the ill mixture of its substance it is said to stutter, and make a noise as hath been said: it is the poyson of Mettals, and makes them brittle that have the least mixture of it, because its incorporation with any Mettal alters the equal temper it had before, and impedes its ductibility; only it doth not infect Lead in this manner, because the exceeding

ceeding great softness and humidity thereof penetrates into, and incorporates with the ill tempered substance of the Tin, so that united together, they remain ductile and malleable. The veins of Tin are not found in every place that one hath a mind to; and yet these rich Provinces are not wholly destitute of them; there is a Farm of Mines named *de Colquiri*, not far from the hill of *St. Philip de Austria de Oruro*, which is famous for the abundance and excellency of the Tin, that hath been gotten there, wherewith they have furnished all this Kingdom, in following the veins whereof, as hath been advertised before, many times they have met with rich parcels of Silver. Near unto *Chayanta* in the *Charcas*, there is another Mine, whence a few years ago they got abundance of Tin. Not far from *Carabuco*, a Village on the bank of the great Lake *Chucuito*, on that side towards the Province of *Larecaja* there be Tin Mines also, which the *Indians* wrought in the time of the *Ingas*, and the *Spaniards* continue to work still;

still; those veins are very large, and rich in Tin, and many times amongst it they meet with Silver; but all of it is mixed with Copper, which makes the Tin more sightly and durable: the fame of these rich veins gave me the curiosity to see them, being desirous that no Mines of these Provinces should escape my knowledge and experience. In the mountain of *Pie de Gallo de Oruro*, there is much Tin, although few know it, and all neglect the working of it because they find not the Silver there which they expect. One of the four principal veins of this famous mountain of *Potosi* is called the Tin Mine, because of the abundance of Tin that was at first found upon the superficies of the Earth, and in digging deeper it all turned into Silver. And in the fields belonging to the parish of *St. Bernard*, where I officiate, a quarter of a league off, or a little more, there be rich veins of Tin, which upon my discovery, your Lordship went in person to visit, whereby, as by other of your noble proceedings, you have given great encouragement.

couragement to those that are industrious in the working of Mines, which hath so eminently encreased the Royal revenue, and the riches of the people.

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CHAP.

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## CHAP. 33.

*Of Quicksilver.*

**Q**uicksilver is a Mineral very well known, of a liquid substance, and fluid like water; it is naturally viscous, very subtil, and abounds in humidity, whence it obtains the qualities of being very heavy, and shining bright, and of being very cold, as it is generally thought, notwithstanding ~~some~~ do affirm it to be very hot, by reason of the subtil effects and penetrating quality that it hath, whereby it runs through, not only flesh, but the hardest bones; and also because sublimated Mercury (which substantially is nothing else but Quicksilver, though altered by the mixture of those Minerals wherewith it is boiled and sublimated

limited, and in like manner is reducible again to Quicksilver) is notoriously known to be poyson, and hot in the first degree; but leaving the determination of this to those that deal in simples, it is certain, that there is so great an affinity between the nature of Quicksilver, and that of other Mettals, that though it be none of them, yet it is convertible into any of them, because as most Philosophers hold, it is one of the principles of which they all are compounded, and most easily unites and incorporates with them; and moreover its very substance is transmutable into true Mettal, enduring the trials of the fire and hammer, as well as those that come out of the Mine. *Raymundus* teacheth several ways how to turn it into Gold and Silver, in a book called *La Disquisicion Eliana*, there is taught a very perfect way how to make Lead of Quicksilver; and if one should suspect the credit of books, in these Provinces there be many eye witnesses, that have Plate by them, which

which they have refined with their own hands by a Copel of Quicksilver, cured according to a receipt given unto them; the which experiments take away all scruple of the possibility of its transmutation. There was very little use or consumption of Quicksilver before the beginning of this new Silver age in the world, then they only wasted it in Mercury sublimite, Cinabrio, or Vermillion, and the powders made thereof called *Precipitate*, which are also called in *Spain* the powders of *Juanes de Vigo*, which have been used to such mischievous purposes, that the world was said to have too much of them, although in bulk and quantity then they had but little, but since it hath been used to collect the Silver together out of Oar, which is ground small, (an invention which the Ancients had scarcely arrived to, and practised it but very little) it is incredible, how great a quantity is consumed by the Founders of Mettals of this Kingdom: for if the abundance of Silver that hath gone out of this Kingdom, hath

hath filled the world with riches and admiration; by it may be estimated the consumption and loss of Quicksilver, which after a most extravagant expence thereof at first, being now by good experience regulated within terms of moderation, is found to be equal in weight to the Silver extracted; and very seldom that the wast is so little. They began to register the Quicksilver that came to *Porosi* upon the Kings account, in the year 1574; and from that time till 1640, there had been received of it upwards of 204600 *Quintals*, besides a vast quantity irregularly brought in upon other accounts: to supply the excessive expence of this Mineral, God Almighty provided the famous Mine of *Guanacabellica*, and in these Provinces subject to the *Charcas*, (of whose Minerals I have desired particularly to inform your Lordship) there can be no want of this Mineral amidst the great plenty it hath of all others; there are Quicksilver Mines in *Challatiri*, four leagues from this Imperial City; there be also of the same near unto *Gharina*: in the Province

of *Omasuyo*, and not far from *Moromoro*, a Village of the *Indians*; six leagues from the City *Chuquisaca*; a few years ago the *Indians* brought Stones very rich with Quicksilver, which by the violent death ( as was suspected ) of the man that profered to discover the Mine, hath remained concealed unto this present.

## CHAP.

## CHAP. 34.

of *Artificial Mettals and Mettalliques*.

ART also produces Mettals and Mettalliques, and in their fabrick aims at, and imitates the perfections of Nature. From a mixture of Tin and Copper is made Brass for Bells, and for pieces of Ordnance, and for other uses. They put a pound of Tin from four to eight *lib.* of Copper, according as the occasion requires. The *Indians* understood this composition, and made use of it for their instruments of force, and for their Arms. as we do of Steel or tempered Iron, which they knew nothing of.

Latten is made of small pieces of Copper put into large *Crusibles*, covered

red with powder of *Falamina*, (which is a Semi-mineral of a yellow colour; there is of it near the Mine called the *Turc*, in the Province of *Carangas*, and also near unto *Pitantora* in the *Charcas*) upon the powder of *Falamina* they strew powder of beaten Glass to cover it, and keep in the respiration, and then they put fire to it, which alters the colour of the Copper, and makes an encrease of Mettal of eight *lib.* in the hundred weight.

For Looking-glasses they make several compositions, although the best is of two parts Silver, and one of Lead. Moreover they make by art, *Cinabrio*, Mercury sublimate, *Precipitate*, *Psorico*, *Esmalte*, *Escoria*, *Diaphryges*, *Cadmia*, *Pompholix*, *Spodos*, *Flor de Cobre*, *Suescama*, *Cardenillo*, *Vermicular*, *Stomoma*, *Herrumbre*, *Ascul*, *Albayalde*, *Sandix*, *Ochra*, *Greta*, *Purpurena*, and *Glass*.

*Cinabrio* is compounded of one part Sulphur, and two parts Quicksilver, well boiled, and sublimated together in

in Glass viols, or in Earthen vessels that are glazed. Mercury sublimate is compounded of half Quicksilver, half Copperas, ground together extraordinary fine, and sprinkling a little strong Vinegar upon it as it grinds, that it may the better incorporate, then sublimate it in Glass viols, as aforesaid; it is also made with Allum, and many times they mingle a little Salt with it.

Dissolve Quicksilver in *Aqua-fortis*, then set it upon a gentle fire, and let the humidity evaporate, and the Quicksilver will remain hard as a Stone, then grind it very small, and set it again upon the fire in a Crucible, (or vessel of Copper, if it can be gotten) and keep stirring the Quicksilver, until it be of a very lively red colour, and then take it off the fire for service, and this is called *Precipitate*.

*Psorico* is made of two parts of *Calchitis*, and one of *Greta*, ground and mingled together with a little strong Vinegar, set it in a Muckhil for forty

days together, then take it out, and in a broken piece of a pot toste it over the fire till it be very red.

The best *Esmalte* is made of Allum, Copperas, and Saltpeter; it is susceptible of all colours, as Glafs is.

*Escoria* is that which worketh out of the Mettal when it runs, and swims upon the top of it like fat, (which we call dross.)

That which remains in the botton of the Furnace, when they melt Copper is called *Diaphryges*.

*Cadmia* (although there be of it natural) is also that which sticks to the walls of the Furnaces, principally wherein Copper is melted, of which they call *Bodrite*, that which is like unto *Cobas*; and *Stracita*, that which is like unto Potsherd; and *Placite*, that which looks like Bark or Shavings.

*Pompholix* is a mealy substance, and looks like Wool, as it sticks to the walls, but dissolves as soon as ones fingers touch it. It grows upon the walls as they melt Mettal. They vulgarly call it *Atutia*.

*Spodo* is very little different from the *Pompholix*, only that it is more impure. It is found upon the walls where they refine Mettal.

Flower of Copper is made by pouring cold water upon the plates of Copper, as they come red hot out of the Furnace, which with the fume raise up little small grains, which they sweep off into a little Iron Fireshovel, and so preserve it.

*La Escama del Cobre* is that which falls off from the Mettal when it is hammered and beaten, and that which in like manner falls off from Iron is called *Stommona*, (although this Greek name rather signifies Steel.)

*Cardenillo* is made by stopping viols of Vinegar with stopples of Copper, and letting it stand ten or twelve days before it is used.

If instead of Copper aforesaid, they use stopples of Iron, it makes *Herrumbre*.

*Vermicular* is very like to *Cardenillo*; take one part of Whitewine Vinegar,



and two parts of stinking Urine, and pour it into a Copper Basin or Mortar, and stir it about with a Pestle of the same, until it grow thick, then put a twenty fourth part of Salt and Allum to it, set it in the Sun, until it coagulate and dry, and it will turn into the form of little worms, from whence it derives the name.

*El Azul* (or Blew) is made by covering a vessel of strong Vinegar (wherein a little *Almojatré* hath been dissolved) with fine sheets of Quicksilvered *Plantada*, full of small holes, and putting it into a hot Muckhil, and after twenty days standing, there rake out the *Asenl* for use.

If in the former case one puts Lead over the Vinegar, it makes *Albayalde*.

Put *Albayalde* in a Spoon or Iron vessel upon kindled Embers, and stir it until it looks very red, and then it is *Sandix*.

*Ochra* is yellow, it is made of Lead burnt until it come to that colour.

*Greta*

*Greta* is made in the refining of Gold and Silver, whereof hereafter.

*Purpurina* is of the colour of Gold, but of little endurance, and lasts not long. Take four or five parts of Tin, and as much Quicksilver, one part of *Almojatré*, and another of Sulphur, and grind them, mingle them in a Glass viol, and distil them, and the substance that remains in the bottom is the *Purpurina*.

In the last place comes the most curious production of Art, and that is the making of Glass. Take two parts of transparent Sand, or powder of Stones, which dissolve in the fire; one part of Nitre, or Saltpeter, or Salt of *Sosa* (which they call the herb of Glass) clear and purifie it with the mixture of a little powder of a Loadstone.

Another receipt. Take two parts of Ashes, and one of the Sand aforesaid, with the powder of Loadstone, and give it a fitting heat in the Furnace.

CHAP.

## CHAP. 35.

*Of the Colours of all Minerals generally.*

**T**HAT those who want experience may the more easily know the Minerals that come to their hands, and that by their eye-sight (the truest informer of all the senses) they may know what they meet with in the bottom of Mines, I shall reduce all sorts of Minerals unto Colours, as to a *Genus* most familiarly known; some sorts of *Greta*, (or Fullers-earth) *Allum*, *Amianto*, the *Arabick* Stone, the *Meliti*, the *Galatiti*, (or the Milk Stone) *Alabaster*, the *Diomond*, *Silver*, *Quick silver*, *Tin*, and *Marble* are white of colour; *la tierra Pingiti*, *Jeat*, *Sori*, *Melanteria* are black; of an ash-colour are the *Eritrian*, and the *Melian* earth; of blew is the

the *Saphir*, the *Ciano*, the *Turkey* Stone, the *Lapis Laculo*, and *el Cibairo*; of green colour is the *Emerald*, the *Prasma*, the *Chrisocola*, or *Atincar*, some sort of *Greta*, and *Vitriol*, or *Copperas*: of the yellow colour is *Gold*, the *Ochra*, the *Chrisopacio*, the *Chrisolite*, and *Orpiment*; of red the *Ruby*, the *Granatte*, the *Balax*, the *Cornelian*, the *Sandaraca*, *Corral*, *la Piedra*, *Seissile*, the *Hematite*, or *Blood Stone*, *Copper*, *Minio*, (or *Vermillion*) the *Lemnian* earth, and *Almagre*; of purple colour is the *Jacint*, and *Amathist*; of a clear blew the *Jasper* called *Boria*; of a greenish blew the *Cardenillo*, and the *Armenian* Stone, or *Cibairo* are of this colour; (and so the Painters call the Colour which they make of this Stone, a verdured blew) of a white inclining to a red is the *Afrodesiaca*; of a red that is whitish is the *Xanto*; between black and red is the *Batrachiti*; of a black inclining to purple is the *Alabandico*; of a yellowish white is the *Topas*.

There be Minerals of any one single colour,

colour, either black or white, or mixed together, as the *Agates*. The *Apsito* hath red veins dispersed upon a black field, and contrariwise the *Nasomonite* hath black veins upon a red field. The *Heliotrope* in his fine green substance hath veins of the purest blood; and in *Saphires* and *lapis Lazuli* are seen very resplendent Gold. Two veins, one white, and the other red, run quite through the substance of the *Egitilla*.

The *Eupatalo* is of four colours, namely, Blew, fiery Red, Vermillion, Pippin colour.

The *Orea* also is wont to be found of so many colours, namely, red, green, white, and black.

## CHAP. 36.

*Of the Faculties or Vertues of Minerals.*

I Shall finish this Treatise with a brief relation of the medicinal Vertues that are found in Minerals, more than what hath been already mentioned, that those that possess them may know how to benefit by them when the occasion serves. Some Minerals work by their occult essential properties, (or specific form) others by the mediation of their Elementary qualities, contrary to those of the disease. Of the first sort some are opposite unto poyson, and others to other sorts of infirmities; and of those that resist poyson some cure the Plague, as the *Emerald*, the *Lemnian* and the *Armenian* earth; others are good against one sort of poyson only,  
as

as the *Saphire* drunk inwardly is against the biting of Scorpions. Sulphur, Nitre, and Copperas are good against the venomous mushrooms: Salt used plaisterwise, is good against the biting of Vipers and Scorpions, drunk inwardly is good against the poyson of *Opium* and Toadstools. Of those that cure by occult quality, some stop the blood from passing to a particular part of the body, as the *Hematite*; others corroborate and fortifie the stomach, when they are hung upon it by help of a string going about the neck, as doth the true *Jasper*: others tied to the left arm restrain abortion, as doth the Eagle-stone, which the *Greeks* call *Ætites*, and if it be bound upon the left muscle, it produces the quite contrary effect, as also doth the *Jasper*: others purge gross humors, as doth the Loadstone; others melancholy, as the Stone-*Armenia*, or *Cibairo*; others provoke to vomit, as doth the aforesaid *Armenia*, *Chrysocola*, *Copperas* and *Precipitate*.

Amongst those that work by their  
Elemen-

Elementary qualities, (although generally all Minerals are drying) some heat the body, as do *Allum*, *Copperas*, *Calchitis*, *Misi*, *Sori*, *Melanteria* and *Cardenillo*; others cool it, as to the *Eritrian-earth*, *Stibium*, ( or *Antimony* ) *Albayaalde* and *Greta*, or *Lithargirio*. Others with the second qualities which they possess, soften hardness, as doth the *Agate*, because it participates so much of the *Betune*; others contrariwise will harden soft parts, as doth the hard *Lead* and *Estibium*: some open the pores of the skin, as *Nitre* and the scum thereof: others shut the pores, as doth the *Sami-an-earth*, and all other Earth that is slimy and tough. Some dissolve Warts, and Biles, and Kernels in the body, as the *Piedra*, *Molar*, and the *Marcasita*; others heal wounds, as the *Calchitis*, the *Misi*, and *Allum*: others corrode the flesh, as doth the powder of the Stone *Asia*, and *Copperas*, and *Cardenillo*: some make the flesh putrifie, as *Quicklime*, *Orpiment*, *Sandaraca*, and *Chrysocola*. *Mercury* sublimate, *Orpiment*,  
Sanda-

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*Sandaraca*, and *Quick-lime* are poyson, because they corrode and putrifie the bowels; so also is *Morter*, *Albayaide*, and *Talco* calcined, because obstructing the passage of the spirits, they choak one.

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*FINIS.*

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THE  
SECOND BOOK  
OF THE  
ART of METTALS,

Wherein is

Taught the Common Way

OF

REFINING SILVER

BY

QUICKSILVER.

WITH

Some New Rules added for the  
better performance of the same.

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Written in *Spanish* by *Alvaro Alonso Barba*,  
Master of Art, Curate of *St. Bernards*  
Parish in the Imperial City of *Potosi*,  
in the Kingdom of *Peru* in the *West-*  
*Indies*, in the Year, 1640.

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*Translated in the Year, 1669.*  
By the R. H. Edward Earl of Sandwich.

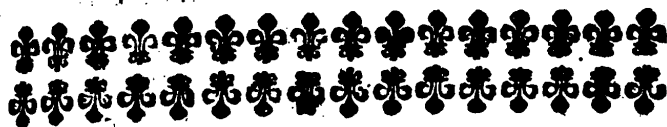
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most of the annotations in  
the 2<sup>d</sup>. part of *Bamba* are  
by W. Murty the discoverer  
of sodium amalgamation

(I)



## *The Second Book of the Art of Mettals.*

### CHAP. I.

*That no man ought to be employed to Refine  
Mettals, but he that hath been examined  
and Licēsed by Authority.*

**T**He abundance of Minerals,  
wherewith God hath enriched  
almost all the Provinces of  
this new world (serving himself  
thereof as a Medium, to other high  
designs of his Divine Providence) hath  
been so great, that it is scarce possible  
to be believed. The Mountain and  
Imperial City of *Potosi*, having already  
A 2 yield.

yielded, between four and five hundred Millions of Peeces of Eight, a quantity sufficient to make such another hill of Silver; it is hard to form a conception equal unto so exorbitant a heap of Riches; but the better to help our imagination therein, know that, if the ground were covered with Peeces of Eight, laid as close to one another, as is possible, they would take up the space of sixty Leagues square, allowing five and twenty Peeces of Eight to a *Vare of Spain* (a *Vare of Spain* is 33. *English* Inches) and five thousand Vares to a *Spanish* League. This glut of Riches, hath been the reason why they have not applyed the care that was requisite, to prevent loss and waste in the Refining of Oar, which speaking with moderation, hath been the loss of many Millions, both for want of giving it due Law, the nature, and difference whereof, they did not understand; and so proceeded by chance, and without good ground, neither knew they well, what quantity of Plate the Oar would yield. And lastly, they destroyed un-

necessari-

necessarily abundance of Quicksilver, whereof hath been already consumed in this Imperial City, more than 234600 Quintals; I know not whether this neglect speaks greatness of mind in the inhabitants of this Kingdom, that they despise to pick up Crums, which nevertheless were sufficient to satisfy the hunger of many Kingdoms of the other world; or whether it condemns the carelessness of so wise and well governed a Commonwealth, that they have not used all possible means to put a stop to so unnecessary a Prodigality. The first and fundamental remedy whereof, is in my opinion, that the Mettals be Refined by one that understands the Art, and is Authorized thereunto by Publick License, after strict examination of his sufficiency, which is required before the admission unto divers callings in the Commonwealth, without comparison of much less importance than this is. The Masters of Refining Works have taken no Care at all in this matter, because how negligently soever they Refine their own Oar, they

A 3

they lose nothing, but have all the Silver, either in the Plates, or amongst the Dross; and that which they Refine for others, yields more profit to these Refiners, the worse it is wrought, because more remains with them in the Dross; but both these are ill reasons to proceed upon, because the making full profit of their own, must cost a double labor, and the ill Refining other mens, redounds to a Publick prejudice.

## CHAP. II.

*What quantities, and what kind of knowledge a Refiner ought to have.*

**I**T is a very great Trust that is put into the Refiners, the whole Riches which this most prosperous Country produceth, being put into their hands without account, or any obligation of the quantity they are to return; their word and honesty only, without reply, or appeal from their sentence, is the only security of the truth, of what the  
Oar

Oar hath yeilded; and it had need be a strong security, when the violent incitation of private interest is to deceive. He therefore that liveth continually amongst these occasions, had need be well furnished with the honor of a Christian, lest having his fingers perpetually kneading in the paste, a good deal do not stick unto them; there ought to be a great deal of circumspection in chusing this Officer, for no mischief that hinders the Refining of Oar, or extravagant consumption, or loss of Quicksilver, can occasion so great prejudice as a Refiner of a wicked Conscience.

Neither yet is it alone sufficient, that his Manners be good, if he want the knowledge necessary to the Art of Refining. He ought to know all sorts of Mettals, their qualities and differences, which of them are most proper for Quicksilver, and which for Melting, if there be conveniency for it. He should know the diseases also that infect Mettals, and the way of clearing them; the accidents of Quicksilver, and the ordinary way



of Refining in great and in little; and in no case let him be admitted for a Refiner, that doth not well understand how to make the lesser Ensay by the Fire, of Oar that is ground to powder, before the Mettal be incorporated together, that so he may know certainly how much Silver ought to be gotten out of that Oar; and he should never give over making tryals, untill he hath obtained it. The want of this one care hath cost this Kingdom abundance of Mony, and is of great prejudice to it, even at this day; two experiments whereof I shall relate, which have passed through my hands, that you may the better estimate the importance of this advice: A few years ago, when I lived in the Province of the *Lipes*, in a Parish which they call *Xauquegua*, a Miner had wrought a Vein, out of which he drew a quantity of very Rich Mettal, although he knew it not; he Ensayed it by Quicksilver, and found it to contain four or five Peeces of Eight the Quintal, and at that rate Refined it all by the great; at length they de-

serted

serted the Mine for being of little profit: Afterwards an *Indian* carried me to the place, I found Mettal in the Moulds that were drawn out, and also in the Vein which had not been much wrought, I Ensayed it by the fire, and found it to contain 900 Peeces of Eight the Quintal, although by the ordinary way of Quicksilver it yeilded but four or five; I discovered this Vein to the Magistrates, calling it by the name of *Nuestra Senora de Begomia*; they built a Mill presently near it, and abundance of Miners flocked thereupon, and have gotten thence a great quantity of Silver.

In the Mountain of *Santa Juana*, out of the Mine of *Berenguela de Pacages*, they got a Mettal like unto *Soroche*s, which by the ordinary Ensay with Quicksilver, appeared scarce to have any Silver at all in it; whereupon the Miners utterly deserted it, untill a Priest a Friend of mine, sent me some peece thereof unto *Oruro*, which I Ensayed, and found them to contain 60 Peece of Eight the Quintal; by my advice he dug a great

great quantity of that Mettal, being laughed at by the Neighbors whilest he was at work to so little purpose (as they thought) but afterwards much more envied by them for the great riches he had gotten.

### CHAP. III.

*Of the knowledge of Mettals, and the differences there are of them.*

IT is almost impossible to teach those, that have not been acquainted with Mettals, how to know them by the sight, because there is so great diversity of them; that there is scarce any stone in one Mine, that resembles stones of the same Mettal in another Mine; no nor oftentimes of the same Mine it self. Nevertheless the Miners reduce these differences unto three general heads, which the *Spaniards* call, 1. *Pacos*, 2. *Mulatos*, and 3. *Negrillos*. *Paco* in the general language of this Country, is as much as to say of a Red colour, and

and such more or less are the Stones, which they call *Metal Paco*, although in *Berengula de Pacages*, they call the Green Mettals of Copper by the same name, which also in these Provinces they give to Mettal of any colour, in contra-distinction to Mettals, that shine like Steel or Glass, and another sort which they call *Negrillos*. *Mulatos* is a colour between the *Pacos* and *Negrillos*; and in the Mines, Mettal of that colour is produced in the same order; it is of a Brown colour, and ordinarily accompanied with some of the *Margagita*; there is less of this Mettal, than of the two other sorts. The *Negrillos* have been discovered by, and take their name from their colour, although all Black Mettals are not comprehended under that name. *La Tacana* a rich Mettal, and usually Black, although there be of it Grey and Ash-coloured, which they call *Lipta* belongs to the *Metals Pacos*, as also doth the Lead (for so they call the Silver Oar) which oftentimes is Black, Grey, Ash-coloured, Green, White, and Orange Tawny, which they

they call *Suco*; and this last year in the Mountain of *Potosi*, there was found of it, of a bright lively Cinamon colour, or very fine Vermilion, a thing which hath not been seen in any other Mine.

(235) The *Soroches* might constitute a fourth order of Mettals, but I agree with the opinion of others, that would have them ranked under the name of *Negrillos*, to which also belongs the *Rosicler*, the richest Mettal that nature hath produced in the form of a Stone; it is shining and brittle, and the powder of it beaten finer with any hard thing, is of the colour of pure blood, it is very like unto *Cinabrio*, or that Vermilion which is made of Quicksilver and Sulphur, which gives a good hint for the finding out of divers other greater secrets. *Cochico* is also of the same kind a very rich Mettal, Massy, but neither so brittle nor spongy as the *Rosicler* is, but it is more full of Lead, and is not so easily beaten to powder, nor gives so perfect a blood colour.

*Soroches*, *Tacana*, *Polvorilla*, *Rosicler*, *Cochico*, and *Negrillos*, are distinguished one

one from another, in the manner following.

The *Soroches* are black, or Ash-coloured, either shining, or without any lustre (which they call dead Oar of Lead) and commonly contains some Silver.

The *Tacana* is Silver Oar close compacted, of a Black colour, without any shining at all.

*Polvorilla* is *Tacana*; not congealed, nor stony, but is rich in that Oar they call *Pacos*, but in the *Negrillos*, not so much, by reason of the mixture of Copper, that it hath.

The *Rosicler* and *Cochico* is Silver Oar with that same Varnish, which hides its own proper colour, and shines, whereby it differs from the *Tacana*. That which predominates in the *Negrillos*, is Copper, either actual, or else Virtual in the Copperas, wherewith it abounds; it always contains Silver more or less, and is usually accompanied with the *Margagita*.

The Black Mettal which feels like Lead, and is smooth (which makes as it were

were Leaves of Trees or Feathers) contains a great deal of *Alcohol*, or Antimony (which in some parts they call *Macacote*) and but little Silver. Those *Negrillos* which have lustre like polished Steel, or Looking-glass, and are therefore called *Espejado* and *Acerado*, are the richer the nearer they approach unto the *Rosicler* and *Cochico*.

#### CHAP. IV.

*Of the sorting of Oar, and the proper manner of Refining each of them.*

**T**He skill of extracting all the Silver, out of any Oar, begins to be exercised in the picking and sorting of the Oar together; the want of care in sorting Oar from Stones, that have no Oar in them, as also the Oar of one sort of Metall from another, hath occasioned much damage; the least inconvenience hath been in the use of Quicksilver; a quantity whereof is lost together with grinding, and other charges about that which is no Metall; the greater inconvenience

venience hath been, where there was Metall, the failing to get out all the Silver, because they have jumbled together Oar of several sorts, and used but one manner of Refining, whereas those Mettals require a different way of handling and time. To Ensay that Metall by Quicksilver, that requires the fire, is to destroy it; to put that Metall in the Furnace, which is not to run, is to endamage the Metall, and to get no profit at all; and although the several Oars be properly assigned, some to the Quicksilver, and some to the fire, yet they have their differences of being easier or harder to be Refined according as they concur, or differ in the remedy, that is necessary to be used for that purpose. The Oar, which they call *Pacos*, that shines or sparkles not at all, is proper for Quicksilver. The *Tacana* also may be refined by Quicksilver, but because it is so very rich Oar, lest it should not be clean extracted, but part of it remain in the Dross, it is better to melt it in a bath of Lead. That Oar which containing Silver in it, yet they

they call by the name of Lead Oar, if it be over gross, will neither grind well, nor cleave fast to the Quicksilver, and is best to be melted together with the *Tacana*.

The most proper way of dealing with the Oar, they call *Machacado*, is the Hammer, the *Soroches* need the fire, the *Rosocler* and *Cochico* are to be melted like the *Tacana*; the *Negrillos* require both fire and Quicksilver, for they prepare all the Oar of that kind by the fire, for the Quicksilver by that means collecting the Silver, either burnt, or boyled, as shall be shewed hereafter.

## CHAP. V.

*How to know the ill qualities that infect the Oar, and how to purge them away.*

OF various and very different qualities are the substances that Nature hath produced in the Veins; that contain the Oars of Mettals, whether they

they be Abortions which the covetousness of Mankind occasions by tearing the Oar out of the bowels of the Earth before its full time, which otherwise would come to be Mettal in perfection, or whether it be excrementious superfluities of the generation of all sorts of Mettals; they be usually called Semi-minerals and are Salts, Allum, Copperas, Sulphur, Orpiment, Sandaraca, Antimony, or Alcohol, Brimstone, both White and black, and Margagita.

Scarce any Oar is gotten that doth not participate of one or more of these ill companions, all of then being hindrances to the extracting Silver out of the Oar, whether it be by the Fire or Quicksilver; those that partake of Copperas, of which sort are those they call *Copaquiras*, are mortal enemies of Quicksilver, which they consume and scatter, and that ill condition is heightened, if Salt be mingled with it, which makes it penetrate more violently, and suddenly; the learned *Raimundus* knew this antipathy very well, and hath left it discovered to us in writing; and

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those that deal in Mettals daily have it in their hands, and yet take no notice of it; this is that, which eats up the Quicksilver, and dissipates the Caxomes of Mettal, and hath occasioned so great an expence of Mettals, namely, Iron, Lead, Tinn, and Lime. Whosoever hath a mind to make experiment hereof, let him mix a little Quicksilver with Copperas well ground, and water, and he shall see in an instant all the Quicksilver dissolved and lost; especially if he put a little Salt to the former composition. This will be no wonder to those that know *Mercury* to be Quicksilver, and that the great change in its substance, is caused by Copperas and Salt, wherewith it is mingled, and then sublimated in the heat of the Fire; this is the greatest poyson to the refination by Quicksilver; although sometimes it is useful, and serves like Treacle to those sorts of Oar, which have use of it, as shall be shewed in it's place hereafter.

This inconvenience is found out, and remedied, with very much ease; grind  
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a little Oar, and put some fair water to it, heat it the more the better, stir it well, and then let it stand a while, then pour out the clear water into another vessel, leaving the Sedement behind undisturbed, prove it by the taste, and you shall well judge what mixture it hath, by it's dry or soure taste; and whosoever desires an ocular demonstration of this, let him set the aforesaid water upon a gentle Fire, simmering untill the moysture be consumed, and he shall see with his eyes, in that which remains at the bottom, either Alum or Copperas. Bathe the Oar in the manner abovesaid, so often as shall be necessary, untill the water, that comes from it be sweet, and without taste, or that stirring it with a bright peece of Iron, it doth not stain it with the colour of Copper, and then that Oar is perfectly cleansed and secure, not to hurt the Quicksilver, when it is put unto it.

Although Sulphur, Betun, and Antimony do oftentimes discover themselves unto the sight, yet a better way

of finding them out, is by the smell, which comes from the Oar, when it is well burnt in the Fire; but for fuller satisfaction herein, they may be discovered and cleared from the Oar in the manner following.

Grind the Oar somewhat gross, and put it in an earthen Pipkin that is not glazed, that hath a great many small holes in the bottom of it, and stop the mouth of it close, then fit a Vessel of water round about it, in such manner as they do, when they clear the Pine Apples from Quicksilver, and put fire under the same Bason of Water, wherein all the smoak that goes out of those little holes will settle, and there you shall see congeal'd and swimming upon the top of the Water, the Sulphur, Antimony or Betun, each in his proper form. When the Oar will smoak no longer, it is a certain sign that it is clear of those impediments, which although they be not direct enemies to Quicksilver in raw Oar, yet the Varnish which they give to the silver, hinders the Quicksilver from laying hold of it, and uniting

uniting it together; and by the brittleness and asperity like Glass which those Oars have that participate of the impediments aforesaid, they cut and divide the Quicksilver when they are stirred together into small White pins heads as it were, which the *Spaniards* call *Lis*. It is necessary to burn this sort of Oar, although it be good to melt them first before they put them into the fierce Fire, because without that preparation the Silver will all be turn'd into dross.

The *Margagita* that is in Oar, discovers it self but too plainly to the eye by its weight and sharp glassie quality, it divides the Quicksilver into small *Lis*; when they stir them together, those ill qualities are taken away by the Fire, if you burn it therein untill its gloss and shining be gone, it doth most hurt unto that Oar which they melt, the abundance of Sulphur whereof it is compounded making a great scum upon the face of the Liquor, which much stifeth the fundition.

## CHAP. VI.

*Of the Grinding of the Oars of Mettal.*

**T**He Grinding of Oar is a preparation absolutely necessary for the getting out of it, the Silver, or Gold that it contains by Quicksilver, and the fineness of the Meal is a principal means of shortening the work and clear extraction of the Plate: one fault amongst many; which the blockishness of this Country has committed, hath been to make the meal very gross, or to leave many lumps therein; there needs no great pains to prove that the Quicksilver attracts or incorporates with it self that Silver which it immediately touches; so that the Mettal which is in middle of any lump remains in the same condition it came out of the Mine, and has more or less loss in it, according to the richness of the Original Oar, and according to the richness or coarseness of the Meal. I have made divers tryals of Grinding those lumps over again, and find

find that in them remains, when least, the sixth part of what is in the Oar when it is first taken out of the Mine, which is very considerable in a whole years work, and incredible in the great quantity of Mettals that have been already gotten. *Agricola* after having taught the way of Grinding & sifting of Mettals which they now practise in the Mills, teaches a way how to reduce it to extraordinary fine Flower in a kind of horse Mill with Stones like Mill stones: he thought this pains to be necessary, although to an end different from that refining which we now practise, wherein it is clearly and indispenseably necessary. I learn't the manner of doing this from one that had gotten a great deal of mony by Grinding the lumps over again, although he did not rake out all the Plate, because he ground them in an ordinary Mill, whose Hammers could not beat it so small as it ought to be, for the lumps either slip'd away from under the Hammer, or being uneven one defended the other from the stroke; to have good Sives, and care in



in lifting them up is of great importance to this matter, but not a full remedy, after the washing of the Oar, especially if it were of rich Mettal is the best gathering up of lumps to regrind. If they burn the lumps, they will yield more Flour, because some of the lumps will calcine and be smoother, and others will swell and grow more spungy, whereby the blow of the Hammer will have better effect upon them. I do use another way of preparation by boyling, as shall be shewed hereafter, which I do hold more proper to be used in all refination by Quicksilver; put the Oar ground and searfed into a skillet in like manner (as if it were already incorporated with Quicksilver, and ready for washing) then pour a sufficient quantity of water upon it, stirring it with a Ladle or hand-mill, whereby all the fine will swim à top, and the gross and ill ground will sink to the bottom; take away the fine with a ladle, put it in the melting pot and boyl it, grind the grosser part again in a Mill or a Morter untill it become all meal; If I desire to  
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make a Xoves of the fine sort after the ordinary manner of refining, I must mingle some pure sand therewith, that it may swell and want the Inconveniencies which that kind of Oar useth to be accompanied withall.

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## CHAP. VII.

### *Touching the Burning of Oar.*

**T**He Burning of Oar is useful for two purposes, viz. 1. That it may Grind the better. 2. That it may be in better disposition for the Quicksilver to lay hold of, and incorporate it self with the Silver that is in it. The reason of the first is plain, and the experience of the latter, since they order all the Negrilla's or blacker Oar in that manner, but generally not understanding the reason thereof. And certainly in all the art of refining nothing is practised so much by guess or chance, and without knowing the ground of it, as this is. Refiners will say, they burn  
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the Oar to clear it of ill qualities, not apprehending that thence it will follow that by fire enough they should quite cleanse and purifie it, whereas the contrary is found by experience, and that according as they burn it more, the worse conditioned is the Oar, and needs the help of some other material to prevent, that all the Silver and Quicksilver too, that is in it, be not lost.

There is but one enemy naturally opposite unto Quicksilver (as hath been said already) and that is the Copperas, and the fire is not only useless for the vanquishing that, but on the contrary it multiplies and encreases it; and if the Oar have no Copperas in it when it is put into the fire, the fire will beget and produce it, as may easily be seen by experiment. In the Burning of Negrillos (or black Oar) in which the fire encreases the Copperas so much, that it is necessary to use other materials in the burning of it to repair that damage, although if they had thoroughly understood this matter, they might have

have cheaper and easier done it, by washing the Oar (as I have said before) untill it were cleared of all the Copperas; The ignorance of which remedy hath been the occasion of great waste and loss.

Other diseases of Oar do not directly injure the Quicksilver, only by the Varnish and Glassie quality which they give, they hinder the Plate and Quicksilver from incorporating and making a Mass together; and therefore the rule in this case is to burn the Oar so long untill it change colour and lose the lustre and sparkling that it had. To know the Oar that of necessity must be burnt (if it be to be Refined by Quicksilver) the lustre and shining aforesaid is a certain sign. The fire will not prejudice that Oar they call Pacos, and if it have any mixture of the aforesaid impediments, it must of necessity be burnt.

## CHAP. VIII.

*Touching the damage that results from the burning of Oar.*

**M**EN having hitherto proceeded by chance as it were, and without certain knowledge of the quantity of Silver contained in a peece of Oar have judged him the best Refiner that has gotten most Silver by one operation, leaving it doubtful whether any more or no were to be gotten out of the Oar, especially in the Negrillos and Oars that cannot be excused from burning. This doubt has been greater, there being less certainty here where there ought to be much the greater; and from hence men have found no less inconvenience by mistaking on the one hand, than on the other; wherefore this manner of preparation hath been esteemed, as dangerous as profitable. With skill and curiosity one may observe many wonders of Nature in the burning of Oar, the parts of Iron and Brimstone, which commonly

monly accompany the Oar, when they come to the fire are converted into Vitriol or Green Copperas; this afterwards is turned into fine Copper; again, the Copper calcined, dissolves in water like salt, the which strain'd and evaporated by a gentle heat coagulates into another kind of Vitriol or blew Copperas, like unto that which they call the stone *Lipes*, and is of admirable Virtue for the turning of almost all Mettals into Copper, the purity of Silver it self does not excuse it from being subject to such a metamorphosis, for if the Oar have in it any Allum, Copperas, Saltpeter, or Nitre by the help of the fire, they will calcine the Silver so, that it will dissolve in water, and not be lay'd hold on by Quicksilver without using some new Artifice, and even Salt alone as it grows incorporated in the Oar, or mingled with it in the fire is capable of producing the same effect as shall appear evidently in the following experiments.

CHAP.

## CHAP. IX.

*Experiments which prove the damage by the burning of Oar if they be not known and remedied.*

**G**Rind a peece of Oar that has Copper or Iron in it, and by the direction of the fifth Chapter of this Book, try if there be any Copperas in it, and if there be, clear the Oar of it by washing of it, and after it is dry burn it well, and put it into water again, and you shall see much Copperas anew produced by the fire; the Refiners daily do this with their hands, although they take no notice of it; and although this experiment be sufficient to satisfy every body, yet for greater confirmation of this secret to grind Oar of Copper or Iron, and melt it into thin Plates, and grind some Sulphur, and in a Crucible or Earthen pot unglaz'd, put a lare of that Sulphur, and upon that lay one of the Plates, and proceed in that order as far as you think fit, stop the

the mouth of it well, that it give no vent; and after it is dry, put it between red hot Coals in such manner as they encompass it round about, but do not touch it; after the Crucible is sufficiently hot, put the fire neerer to it, and at last make the fire fierce; but not so much as to melt the Plates; then take it out and the Plates will look black and be brittle, grind them very fine, and put the fourth part of their weight of beaten Sulphur, together with them into a peece of broken pot or earthen Basen upon Embers, heat them so as you heat an Ensay of the black Oar, stirring them continually untill the Sulphur have left smoaking, and the oftener you repeat this the better; last of all being well beaten and hot, or else the water hot, and after a little time boyl the water, and if it colours bright Iron or a Copper colour, that the water evaporate by a gentle fire, untill it begins to be covered with a kind of Cream, then take it off and set it a cooling, and it will congeal into most beautiful transparent Copperas, Green if the Plates were

were of Iron, or blew if the Plates were of Copper.

Dissolve this Copperas or Stone *Lipis* in water, and put Steel or Iron to it, and it turns into most pure Copper, smooth, and soft as gold after it is new melted. If one melt Lead or Tin, and pour it in small drops upon the face of that water, the whole superficies will be turned into Copper, and the oftner it is repeated, the greater quantity of the Lead will be transformed untill no Lead remain.

Tin is very easily turned into brass. I was the first which in the Province of the *Lipis* found out and published these secrets. Also Silver is turn'd into Copper if it be made very fine, and with much Salt (an experiment which ought to be as highly esteemed by the Refiners, as the turning Copper into Silver) *Aqua fortis* is a common thing, if it were not, its vertue would be held miraculous, it turns Silver into Water, and calcines it into dust; it is made of Copperas or Allum and Salt-peter, the Spirits that flye from any of these substances, when  
Oar

Oar that contains them is cast into the furnace, works the same effects: with beaten Brick and Salt especially of the rock is made a Cement, wherewith they separate Silver from Gold; these two attract the Silver to themselves and with the heat of the fire only calcine it; in the burning of Oar they have the same effect; the Silver being calcin'd in either of the aforesaid manners if it be put into water dissolves in it like Salt, and the Water looks white as milk, and will spot ones hands or nails if you touch it, notable signs of *Aqua fortis* in Silver, whereunto Refiners ought to have great regard, that it destroy not their Silver; these inconveniencies there are in the burning of Mettals, besides another which anon shall be discovered, and though the proper way of avoiding them is casting or melting the Oar which renders useful, not only that Mettal which is precious, but also the baser sort, as shall be shewn in its place, nevertheless because all places do not afford conveniencies for melting down Oar, nor all Oars contain  
C Mettals

Mettals rich enough to pay the cost, let the aforesaid inconveniencies when they happen be remedy'd according to the rules which shall be set down hereafter, although it be impossible to prepare Oar without burning so as to yeild that quantity of Plate it did by Quicksilver, as shall be shewn where the refination by boyling is treated of.

### CHAP. X.

*whether the Oar ought to be burnt in the stone or in the meal.*

**T**hey use to burn Oar in the Stone or in the Meal, and burning it in the Meal, they better understand the nature of the Oar, for taking care to stir it well about, and mix it equally in the Furnace, taking out a small quantity, and putting Quicksilver and Salt thereunto in a short space of time; by the disposition of the Quicksilver you shall quickly know what the Oar is, whether it begin to grow like Lead or

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no, and whether the Lead be gross or fine, or whether there be need of more materials or no, or whether to continue, or stop the burning of it, according as every Refiner by his own experience hath found to succeed best with it out of that Oar which is burnt in the stone, cannot be chosen this equality, because the force of the fire cannot be equally communicated to stones in a divers situation and of different bigness; for it is clear that the small stones are sooner heat than the greater, and those that are in the Center of the Furnace, sooner than those that touch the sides, but this manner of burning is subject to least damage, besides that it facilitates the grinding of the Oar.

It is a great error to burn Oar already grownd by reverberation, because the fierceness of the fire; burn the Sulphur or Betun which it contains, and suffer it not to discharge it self by little and little, but obligeth it to mingle it self with the Silver, and altogether to turn it into dross; moreover the force of the flame raises up the settled parts of the

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Silver

Silver when they stir the Oar, and turning it into smoak, blows it out of the Furnace. The most secure way of burning Oar already grownd, is to do it by a Tostadillo (or preserving Pan) made in the fashion of a Furnace, as shall be directed hereafter, and because the Meal is wont by the fire to gather into little lumps, or else to grow spongy and gross, it is convenient to grind it over again, before it be incorporated, the best way of all as has been said were to burn it in the stone, because it facilitates and saves a great part of the grinding, and avoids the inconvenience of the fine Silver flying away in the smoak, and where the Oar is incorporated in hard Peble and Flint, which are very untractable stones, it is necessary to burn them. Other sorts of Oar ought not to be burnt alone, but in Meal with the mixture which shall be prescribed according to the ill qualities wherewith they are affected.

CHAP.

## CHAP. XI.

*Of Materials to be mixed with Oar, when they burn it.*

IT is no extraordinary, but a common thing for Iron to be engendered in the Gold and Silver Oar, and the Oar, that is so affected, is most difficult for burning or fundition either; it may be discovered by the slowness of the heat's penetration into it, and also by a Loadstone, passing it over the Oar, after it is well burnt, and grownd, which will snatch up the Iron, if there be any, and more or less of it, according to the quantity mixt with the Oar. This kind of Oar after it is grownd, ought to be mixed with Sulphur, or which is better with the Meal of Oar that hath Sulphur, or Antimony in it, and in such proportion as the quantity of Iron in the Oar requires: when they are mingled, heat them upon the Tostadillo untill that taking out some of the Meal, and Ensaying it according to custome;

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the Oar is found to be well conditioned. Sulphur is the destruction of all Mettals, gold only excepted ; it hurts Tin less than other Mettals, and Iron most of all, and that is the reason why the Sulphur, and Iron combating with, and destroying each other in the Furnace, the Silver is left alone by its self. In like manner is Oar cured, that contains Sulphur or Antimony, being mingled and burnt with the Oar, or dross of Iron after it is well grownd.

That Oar which contains Orpiment, or Sandaraca, ought to be burnt which Soroches, which is Oar of Lead and Sulphur ; that which contains Betun black or white must be burnt with dross of Iron, and powder of white stones, whereof they make Lime: Besides what hath been already said, the diseases of Oar may be known by putting a little of it grownd somewhat gross upon a red hot plate of Iron, observing well what fume it makes, which if it be white or black, participates of Betunes of that Colour, if it were yellow of Orpiment, if red of Sandaraca, if it be yellow in  
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the middle, and green on the out sides, of Sulphur, and likewise the earth that is drawn out of the Mines, together with the Oar, will oftentimes send forth fumes of the like kind of colours.

## CHAP. XII.

*what the Refiner must do before he incorporates the Caxon.*

**T**He Refiner throughly understanding what has been said before, the Oar being well grown'd & ceased with that curiosity and circumspection which is necessary (so that it need not be picked) Before he doth go about to incorporate the Caxon, and before he burns the Meal, if there were need thereof, let him set apart three or four pound of the Flower well mingled, and stirring it together again afresh, take a small quantity, & make two Ensayes thereof by melting in such manner, as shall be shewed hereafter ; whereby he shall certainly know what Silver the Caxon contains, and how much he may expect to get out  
C 4 of



of it. Laying down this ground, that the Oar is of that they call *Pacos*, and needs not burning, nor contains *Cop-peras*, nor *Coppaquiras*, take out some in the manner abovesaid, and Ensay a pound of it by Quicksilver, but first pour upon the Oar a good deal of fair water, more than is ordinarily necessary, and let it stand a while, and if there arise a scum, or cream, that is gross, or oily, scum it off, and let that water run out; and repeat the same with fresh water, so often, untill no such scum arise, then take out so much water as is superfluous, and put Salt and Quicksilver to it, and without any other material proceed in repeating, to cast in those too, marking well the operation of the Quicksilver, whether by accident it meets with more Quicksilver; whether it turns little or much to Lead, whether it dissolves or remains intire; if it fastens upon the Oar without the help of any Material, it is a sign, that the Oar doth attract it to it self, repeat the operation so, untill you find that the force of the Silver, and the repetition doth waste  
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the Quicksilver, which if it do the work is excellent, and will produce the Silver in dust as small as Pin-dust, which must be gotten together by sifting, and the remainder which is mingled with Quicksilver must be gotten by washing, and so you shall have all that the Oar contained, agreeable to the experiment, which was made by melting. The Oar of *Berenguela de Pacages* is of the quality afore mentioned, a great deal whereof was spoiled at first, by working it with materials, supposing it impossible there should be Oar, which did not stand in need thereof; now a-days they Refine with only Salt and Quicksilver, and get the same quantity of Silver, as they did by melting, which is all that the Oar contains; this Oar is called *Cobrico*, if the Ensay doth shew Lead, for so they call it, when the Quicksilver loses its own bright colour, and looks like Lead, then other materials are requisite to cleanse it, that it may the better take hold of, and gather the Silver together; those materials that have this virtue are Iron dissolved,

solved, Lead or Tin, and Lime slacked, or unslacked for some resemblance it hath to Mettal; any Oar may be Refin'd with the help of any one of these materials, although that seems to be best, which is nearest of kindred to the mixture of the Oar. If the dust of the Silver and colour of the Quicksilver be dusky and blackish, then Iron is most proper for it, for that which looks like Lead, Lead it self is best to that which is clear; Tin is the best for Quicksilver that looks as if it were guilt and hath Copper in it; Lime is the best this material which is most convenient they throw in by a little and a little at a time by measure and weight; untill the Quicksilver look clear, and lay hold on the Silver, and by this they make the account by the great, how much materials they are to put into a Caxon or Chest, according to the number of kintals it contains.

If the Quicksilver be changed into white powder or Ashes, and often passing it again through the Oar, do not make it finer, it proceeds from the weight

weight and solidity of the Oar; the proper accidents of those they call Soroches and Magagitaes, and those other Oars that sparkle and have need of burning, as have been said before. Hard stones that have no Silver in them cause the same accidents in Quicksilver, wherefore looking upon it reduced to white powder as aforesaid, if you do not discern either black Oar or Margagita amongst it, there was no Silver contained in that Oar which was Ensaied, and is good for nothing.

If in the lesser Ensay the Quicksilver be bright and entire, and falls to work, laying hold on the Silver, there is no need of using any other material, all Ensays are made with a very little Quicksilver, that there may be room to use any other materials, if there be occasion for it, if not that more Quicksilver may be added, and so the work of Refining is perform'd with greater brevity and security, as shall be shewed hereafter; and let not the Refiner cease making experiments, untill the lesser Ensay which he makes by Quicksilver, cor-

correspond with that which he makes by melting, and let him proceed respectively in the greater Refining of the Caxones.

### CHAP. XIII.

*Continuing the Rules of the last Chapter, touching Oar that has need of burning.*

**I**F the Oar have need of burning, as hath been said before, and the Ensay by melting made, and the Refiner assured of the quantity of Plate the Oar contains, let him burn it, observing the rules of what he is to mix with it according to the bigness of the work, and the convenience he hath to perform it in, but in no case let him burn any Oar with Salt; besides that it helps to calcine the Silver, it gives a stronger force to those ill fumes which are in the Oar to penetrate into and spoil the Silver. One cannot well tell the set number of hours, wherein one ought to let Oar

con-

continue in the fire, but the sure rule to know when the Oar is well conditioned, is by Ensayng some of the burnt Meal; when if the Quicksilver remain intire and clear, and Silver sticking about it like driven Snow, then it is burnt enough, and the fire continued, will certainly produce this effect if the Oar be mingled with due materials, and in a just quantity; in order to which, as also in the Oars they call Pacos, let them make lesser Ensayns to know what quantity of Materials are to be put into the Furnace with every Kintal of Oar, but because these Ensayns are seldom made as they should be, let the following rules be observed.

When the Oar in the Furnace leavs smelling ill, it is a sign that it has discharged it self of all the Sulphur and Antimony that is in it; when that Oar charged with Betun, and at the first coming into the Furnace, throwing out a thick and black smoak by degrees, sends forth a thinner and whiter fume; it shews that inconvenience to be cured.

When

When Oar changes colour, losing the sparkling that it had, and of *Ne-grillo* becoming *Paco*, 'tis a certain sign that it is well disposed for the Quick-silver, although in this there be exceeding great latitude.

That Oar which contains Copperas, if it be to be put in the fire, must first be cleansed by washing in Meal, as hath been said, otherwise when it comes in the Furnace, it will become very red as may be seen if one burn Copperas alone in the fire.

When Ensayng a little of the Meal burnt, the Quicksilver begins to look like Lead, it is a sign that by the heat of the fire the Copper or Iron which the Mettal contains (together with the mixture of Sulphur) the Antimony or Margagita are turning into Copperas, and that the faster, the longer the fire continues.

Take a pound of the Meal out of the Furnace, whilst it is hot put it into a Vessel, and pour water upon it three or four fingers deep, then stir it a while and let it settle, then if the water turn white,

white, or stain ones Nails, or change the colour of the Taggs of points put thereinto, it is a sign that the Silver calcineth and dissolves in the water like Salt; save this water in a glass vessel, and pour more upon the Oar two or three times, or as often as is necessary, till it do not turn white; and all the Silver that was calcined, will be gotten out of the Oar; let the water evaporate by a gentle fire, and all the Plate will settle in the bottom, and become fit for use by melting.

If the water into which the hot Oar was put, give no signs of the Silver being calcin'd, dip polished Iron into it, and if it come out coloured like Copper, there is much Copperas in the Mettal; wherefore wash the Mettal in the manner as hath been taught, untill it be cleared of the Copperas, and change not the colour of Iron; save the waters of this operation, for they are very useful in the Refining Oar that have need of it, and if you should take out and melt the Sedement that is in the bottom of that water, fine  
Copper

Copper will be produced thereby, or Silver if any such have been calcin'd.

Ensay the Oar so disposed in little by Quicksilver, as hath been said of the Oars Pacos, untill by experience you have found out the way how to Refine in greater quantity, so that you may get as much Silver as you know that Oar contains by Ensayes of melting in the fire. Let no body condemn these for tedious and unnecessary curiosities, for there is nothing more profitable and important in these matters, nor less commonly known; and by the care & pains of a few days the Refiner will be acquainted with the sorts and qualities of Oar that come to his hand, and know how to proceed with them without wearying himself with making Ensayes; but for all that have been said, the Oar never comes to be perfectly Refined, untill the Silver little or much that it contained be purified and whitened in the Meal, and it is not impossible to put it in that estate. Since the Oares Pacos of Lead may be reduced thereunto only by

by burning, and the Negrillos and others also that have Sulphur in them which stains and blackes the Silver, although it must be a long time in the fire before it comes to this, and both one sort of Oar, & the other must have boylings and liquors often passed through them, which do cleanse and whiten the Silver, such as Millo, Allum, Salt and others, the Oar being in this condition, needs no other material but Quicksilver, which in less than four days time will gather together all the Silver, and be very little consumed it self, because the short time of operation, the absence of ill qualities and the seldom times repassing it through the Oar, will not regrind, or disperse it to powder, which is the principal reason of the loss of Quicksilver, as shall be shewed hereafter.

## CHAP. XIV.

*Of the nature of Quick-silver.*

**D**Eferred untill another occasion, which it may be in due time will offer it self to treat purposely of Quick-silver, and some excrements thereof, of no less profit than curiosity; for the present, I shall only say with that Phænix of Science in his intellectual Art, which all do follow, who treat of the hidden Philosophy of Mettals, that Nature hath made this body of so uniform a substance, and of parts so perfectly united, that even the fire his greatest enemy, as the vulgar think, is not powerful enough by dividing to corrupt, and destroy it as it visibly doth all other Mettals and bodies in the world, except Gold and Silver. The Quicksilver retains its whole intire substance in the fire, if it be prepared on purpose for it, which many persons know how to do, or else all of it will flye quite away in the form of smoak, and meeting with  
any

any body that refreshes it; it will condense therein in its own proper form without being diminished one hair, either in weight or quantity; neither also do the ill qualities that are ordinarily found in Oar corrupt Quicksilver in Veins wherein it is begotten, nor in the Chests wherein they refine, for although Copperas do dissolve it in that manner that it seems to be consumed, and being sublimated in Copperas, and common Salt, it is transformed and turned into that which we call *Mercury*, that one would think it were totally destroy'd and turned into another species yet it is not so, but all those accidents have their remedies, and it is neither impossible nor very difficult to quicken it again, and unite it, and in its place I shall shew how this is to be done.

## CHAP. XV.

*Touching the causes and differences, of that which is called Lis.*

**Q**uicksilver dissolved, and divided into very subtile parts, is commonly called by the Refiners *Lis*, which shews its self like an eye-brow, in the matter *Purumnia* when the Oar is Ensayed; and from it the experienced Refiners take their indication of the quality of the Oar and condition of the Caxomes; it is caused by the often passing of it through the Oar (a thing inexcusable in the ordinary way of refining) although it hath no ill quality at all, but if it hath Coperas in it, it will grind the Quicksilver in great extremity, as hath been said. If Quicksilver be without any foreign impression upon it, and be dissolved into *Lis*, which is white, 'tis called *Lis* of Quicksilver; *Lis* of other materials, is called that which is made by Quicksilver of Tin or Lead, and *Lis* of Silver is the fine, and subtile

subtile parts of Silver, made by the re-passing of the Quicksilver through the Oar, but not as yet joyned or incorporated with it; which when it is, they call by the name of *Pella* (which signifies a Ball or Pellet) Quicksilver is susceptible of divers colours, which appears in the *Lises* according to the different matter which accompanies that Silver Oar into which it is thrown; these colours are reduced into three *Genuses* as it were, which comprehend under them several other *Species*.

Those three are  $\left\{ \begin{array}{l} \text{Cleer.} \\ \text{Lead Coloured.} \\ \text{Spotted.} \end{array} \right.$

The Quicksilver looks cleer, either when the Oar hath no Silver at all in it, or when the Silver it contains is fine without any Alloy or mixture; in that case the Quicksilver will attract, and cloath it self with the dust of fine Silver, without losing the liveliness of its color; which when it changeth, they call it Leaden, for its likness unto the colour

lour of that Mettal, although it always is accompanied with signs that the Oar contains Silver, unless it be that the Lead, for so they call it, proceed from false principles, and those have a manifest cause; although little taken notice of, as well as the other proceedings in Refining, which hitherunto have been governed by chance. It is Copperas alone (the mortal enemy of Quicksilver) which gives it the false colour of Lead, in like manner as it doth to other Mettals the colour of Copper; the other Lead colour is a certain sign of Silver, because ordinarily it is made in raw Oar, that is mixed with divers other bad things, the which attracting to it self the Quicksilver; the Quicksilver lays hold of, and carries away both the Mettal, and also its bad companions, who give it that strange colour; this is the ground of what is treated of in the twelfth Chapter of this Book, and the reason of that assertion, that the black or obscure *Lis*, or colour of Quicksilver proceeds from Oar that is mixed with Iron; if the Quicksilver have

have a deep Lead colour, then it hath Lead its self in its company, if it be something more clear, then it hath Tin, and if it look as if it were guilt a little, Copper. Whether the *Lis* be of Quicksilver, Silver, or of other materials is easie to be discerned, for the *Lis* of Quicksilver is very fine, white, but wanting quickness, and when it falls together with the water into the Tray, it doth not run up and down, but remains as if it stuck to the bottom, and if you rub it with your finger, it will unite into lumps of Quicksilver. The *Lis* of Silver shines, and is like Pindust, or finer according to the richness of the Oar, when they let the water out from the Oar, it runs about the bottom of the Tray, and if you rub it with your finger, it will gather together into Pellets; the *Lis* of other materials is as it were a middle thing between the other two, and being reduced into a body by rubbing it with ones finger, it unites it self with the touched Quicksilver.



## CHAP. XVI.

*whether it be fitting at first to put in all the Quick-silver, and other materials at once or no.*

**T**He Oar being in good disposition, and the Refiner by the foregoing rules being assured how much Silver the Caxon contains, and what proportion of Quicksilver and other Materials is necessary to be put in, that when it comes to be washed, it may yield three parts of Silver Pellets, and one of Quicksilver, it may be doubted whether all the Quicksilver and materials aforesaid, should be put into the incorporating vessel at once, or no; and the most part, if not all the Artists of this Country did use to do it at once; untill about twenty years ago, when I came to live in the Province of the *Lipes*, I perswaded them to the contrary according to rules, which I had learnt in such like operations, out of *Raimundus Lullus*, which do evidently agree with

with the ordinary course of Nature, that brings to perfection all thing by a slow and gentle growth, and not suddenly nor violently. A very little fire is sufficient to burn the whole world, if the combustible matter were put into it by little and little, proportionable to the force of the fire; but if all that matter, or an over-great proportion of it should be laid upon the fire at once, it would choak it, and put it out: the natural heat of Animals is subject to the same inconvenience, and the same happens proportionally unto the Chests of Metals, besides that by experience it is found, that the extraordinary cold of much Quicksilver, doth accidentally bind up the Oar, and hinder the Refine, as on the contrary any heat hastens it; moreover if because they have judged ill of the remedy to be put into the Chest, the Caxon despair, and the Quicksilver dissolve, the remedy will be the easier, the less loose the Caxon. And if there be need of using Tin or Lead, which cannot be applyed without Quicksilver, that will be added with

with less danger, the Quicksilver being already. The same damage or greater follows when they exceed in the quantity of Materials, they put in to the Oar which hath need thereof, because it dulls and deadens the Quicksilver, so that it will lay hold on no Silver at all, and can very hardly ever be reduced into that condition it ought to be. After many days spent in repassing the Quicksilver, and dressing of the Oar, let the Caxon be incorporated and washed with a third part of Quicksilver at the most, and at first put in half the Tin or Lead, that is requisite to be spent, for so the Quicksilver will the better lay hold of the Plate, and draw it out presently before the Materials are consumed, which they call *Aplomar*, whereby will be avoided the danger of the dry Plate, which like froth swims upon the water that comes out, and is the occasion of much mischief. If the Caxon stand in need thereof, proceed to put in more Quicksilver, and other Materials, always diminishing the quantities proportionally in such manner,

manner, that it may go dry and not wet, for so there will be no occasion for much *Lis*, and the Pellets themselves will serve to get out the rest of the Silver, whereby the refining will be soonest and most securely performed; if it be needful to Refine with Lime, the rule already prescribed for Materials will not serve, but the Lime must be put in all at once, and with it repass the Caxon very well two or three days before you put in the Quicksilver, taking especial care that you do not put in too much of it, because it is the great hinderance that the Quicksilver doth not lay hold of the greater Plate, and it is more hard to correct than other materials.

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## CHAP. XVII.

*Of the often repassing the Quick silver through the Oar and the effects thereof.*

THE chief and principal end of letting it soak through, is to divide the

the Quicksilver into several bodies; that it may every where lay hold of the Plate, also with that motion it is heat, and better disposed for the work; and last of all by that frication the Plate is cleansed and purified (which is that they call wasting the Materials) all of them, things most necessary and important, although they cause an unpardonable damage, that hath been the loss of many Millions in the wasting and consumption of Quicksilver, for the repassings have been the foundation of this inconvenience, by squeezing the Quicksilver through the grosser and finer parts of the Meal into such little Atomes (which they call *Lis*) that scarce have weight or dimension, which when they wash, the Caxon doth not fall down into the Tub at the bottom, but being over-drowned and mingled with the Lamas or mud of the Meal, it stays and is cast away with them; this inconvenience may be prevented by two cautions, the one is, that the first and second day after the incorporating of the Meal of Oar in the Caxon, they give not  
above

above two gentle repassings, so that the Quicksilver may be divided, but not into too small parcels, because before it hath gotten a good body of Silver, it is subject to part it self over finely. The second is as abovesaid, that they put in the other materials dry, and not wetted with Quicksilver, putting them in by little and little when most it be in the proportion, one part of Quicksilver to two of Pellets. Let no body deceive themselves, that although the Meal in the Caxon contain other Materials sufficient, if it be much bathed with Quicksilver that it shall be secured from the former inconvenience; for contrariwise it will rather be subject to a greater prejudice, for of necessity the repassings will make *Lis*, and if it happen by some accident as it very well may, that the Materials be quite consumed instead of the *Lis* made of them will remain only *Lis* of Quicksilver. In the *Lis* of Plate there is not that danger, that by the often repassings the Silver should be wasted or consumed, rather it is thereby better refined, and better embraceth

ceth and uniteth it self with the Quick-silver.

## CHAP. XVIII.

*Of divers accidents, which happen in the way of Refining by Quick-silver, and their remedies.*

**I**N the progress of this kind of Refining, divers accidents are met with all in the Caxones (or chest full of Oar grownd to be Refined) all which are discovered only by the Quicksilver, which as in a glass represents the good or ill disposition of the Mettal, which in themselves by reason of the fineness of the Meal into which they are grownd, and a mixture of earth in the Oar, cannot be discerned.

If the Quicksilver be very much charged above what it ought with materials, that is to say, Lead, Tin, Iron, or Lime (which the *Spaniards* call Quicksilver Tocado) it will not appear round but flatted, or rather prolonged  
like

like little Worms, and if you stir it about the Tray without water, it will make drops with little tails, and stick to the sides of the Tray; and when it is of this condition it is a sign that it is killed, and its virtue obstructed from laying hold of the Silver; this evil is remedied by much repassing, not without great cost and expence of time; the quickest and most efficacious remedy is *Copperas*, or the water thereof, which I have shewed how to make and to keep in the 13. Chapter of this Book, put it into the Caxones at the same time as you do the Quicksilver, and other Refining Materials more or less, according as there is occasion, and you shall instantly see the effect of it; the reason whereof is plain, for (as hath been said) *Copperas* dissolved in water converts the baser Mettals into true Copper; so that the quality of cold which they had before, and wherewith they choaked the Quicksilver, being turned into heat (the property of Copper) it is the cause of reviving the Quicksilver: From hence is grounded the

the practice of putting Copper grownd small into the Caxon, which is found very profitable for the purpose afore-said; hence also it comes to pass, that all Oar of Copper although it be rich is not proper to clear Quicksilver with, or to be used in the Refining to make it Aplomar, unless it have a great deal of Verdigrease or Copperas. The same account may be given of the Virtue that is found in those they call Magistrates, which they use in the Refining to qualifie the Caxones with heat, and to make them Aplomar, the which effect is produced from the burnt Copperas that is in it, as may be seen in their composition, which for better satisfaction I shall here set down.

Burn Oar or Copper, and grind it well, then with an equal quantity of Salt knead it into a body together, and having made it into loaves burn it again.

Others do mingle but one part of Salt, with two parts of Copper Oar, which they make up into a body and burn, and to one Kintall of that beaten

to powder, they add half a pound of filings of Latin. *Brass or Zn?* p. 143

Another Magistral is made of Lamas. *Probably tailings - H. Wurtz*

Relabes and Salt, an equal portion of either soundly burnt together.

Another is made of that Oar where-with they Refine the Relabes and Salt put together in equal portions.

Another sort may be made of Copper Oar, Relabes, Meal of that Oar which is to be Refined, drops of Iron and Salt, all put together in equal portions and burnt in loaves.

Another is made of three parts of the Lamas burnt, and one part of Salt. Every one inventing such like compositions or proportions, according to his own fantasie, and experience: the foundation of all these Magistrales being the Copperas which the fire produces in them, as may be seen and separated from them, by whosoever shall please to go about it according to the rules that have been already delivered, which seems to confirm that which *Pliny* says,

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trea-

*Lanna is the same applied to a furnace in an arrastra - G. J. 53*

treating of Copper, namely that it is begotten of stones burnt.

These Magistrales are to be used with the same carefulness as hath been already said of the materials, namely they are to be made trial of before the incorporating of the Caxon, that by these lesser Ensayes it may be known what proportion is fit to be put into the Caxon, according to the number of Kintals it shall contain, for if the proportion do exceed, another great inconvenience will be produced thereby, namely that which follows.

## CHAP. XIX.

*In prosecution of the Chapter foregoing.*

**A**N Accident contrary to that mentioned in the former Chapter, and an occasion of great waste of Quicksilver, is of the colour of Lead, that is to say, when it is affected with no other mate-

material of inconvenience, but only that discolouration, and the damage is the greater, if the discolouring hath proceeded from Copperas, and that there be much Quicksilver divided, and running loose about. Quicksilver squeezed out of the lumps is very round and lively; if it be divided, the parts of it, although never so small, do not run into a Cylindrical figure, but into a Spherical, this mischief is cured by the contrary materials, which as hath been said before cleave unto the Quicksilver, nevertheless the Medicine, which by its particular qualities, attraction, and natural sympathy cure this evil is Iron, which reunites the Quicksilver, and gathers it together into a body after it was dissolved, corrupted, and in a manner turned into another substance by the Copperas, which shall be treated of more at large hereafter, when we speak of washing the Caxones.

No certain rule can be given, what quantity of materials to put into the Caxones, that have failed in the operation, because the mischief and the causes

thereof are not always the same, but this general rule must be observed, that they do not repass the Caxon with Quicksilver, till they have first Ensayed a small quantity thereof, and thereby have understood what is necessary. After that let them take a third or a fourth part of the Caxon, and mingle that with the whole proportion of the Materials, and stir it well together, till it be very well mixed, and incorporated one with another, then mix this with the rest of the Caxon, stir them very well together, for after this manner the Medicine will be best, and with most equality distributed in the Caxon, especially if the Medicine to be put in be very small in quantity. Have a care to use the means, that is requisite to avoid falling into the first inconvenience of overcharging the Quicksilver, and remedy the second mischief with all possible speed, because otherwise the Copperas will transform the Quicksilver in such manner, as if it were quite eaten up and consumed. When Ensayng the Caxon the Quick-  
silver

silver is found in the bottom of the *Purumia* Vessel divide it in small grains <sup>divide</sup> not run together in a lump, it is a sign the Refination is imperfect, and that some little hairyness, or crisping encompasseth the Pellets of Quicksilver, and hinders them uniting; the want of materials is commonly the cause of this, or else the over-much allay of other Metals, which as well as the Plate attracts the Quicksilver it self. Repasses, the Relabillo burnt by reason of its sharp cutting quality is profitable to cleanse the Quicksilver: some put in ashes, but the most proper and natural remedy for it, is that which they call Millo or Allum, which makes the Silver white, and is very ordinarily to be had in great abundance amongst the Mines here at *Potosi*, and in *Guaico de Santiago* there is a Spring that runs continually with this Allum water.

When the Caxon hath not been repassed equally, or not served with as much Quicksilver as is necessary, or in some places doth not unite it self with other parts of the Quicksilver, that had

gotten Plate already, the cause thereof is that they call dry Plate: In Ensayes you shall see it swim upon the Relaves crisped like froth, and if it be not scimmed off, and saved before the cleansing the Caxon, it will swim at the top, and run away with the Lamas to the great detriment of him that owes the Oar; if the Quicksilver dry, having nevertheless materials sufficient with it, it is no inconvenience at all, because it will unite one with another the better, or else that part which the material possessed being wasted away, the other moist parts remain in the Quicksilver to unite it self with the rest of the Pellets; that dry Plate which wants materials, cannot safely be gathered together by loose Quicksilver, untill the Caxon be ready for cleansing; the proper remedy for this is to repass the Caxon with Pellet of Silver, not over small, so shall the dry Plate be collected together, and the greatest part of the *Lis* also, if there were any there.

CHAP.

## CHAP. XX.

*How to know whether or no the Caxon be ready for washing.*

**T**Here can no certain time be prefixed, wherein one is obliged to wash the Caxones. It's maturity is hastened by frequent repassings by the outward heat of the Air, and the inward heat of the Copper or Copperas; and other things of that kind of virtue, and such as clear and purifie the Silver; a principal cause whereof is the burning of Mettals. On the contrary, the work of Refining is prolonged and slackened by fewer repassings, if the Air be cold or Frost, if the Caxon be over foul, that the Quicksilver loses it's clearness in passing through: but letting pass these, and other accidents, let us come to the point of gathering out the clear Silver mixed with Quicksilver, leaving the earth behind, which is called washing the Caxon, whereunto no small experience is necessary, for if the

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Caxon



Caxon be not ripe for washing, that plate which the Quicksilver hath not laid hold on, is likely to be utterly lost, or if it be not, it must be grownd over again, so that at least one loses much time and labour, and Silver too in the repassings, besides other hazzards.

The rules hitherto delivered for the discovery of the disposition of the Caxon are subject to very great error: such as it's appearing so well to sight as if there were need of no more Quicksilver, to find the *Lis* of the Plate all gathered together and finished, and that of the Quicksilver beginning to come; the substance of the Plate, and Quicksilver being clear, and gilded as it were with other signs, all of which do not secure the judgment from being erroneous, because these may be produced by other accidents besides the maturity of the Caxon. The only sure and infallible sign is to see whether the Quicksilver hath gotten all the Plate, which it ought to do according to the proportion shewed by the lesser Ensay of fire, which was made at the beginning, and if it hath

hath not arrived to that, although it hath many more good signs than hath been already mentioned; wash not the Caxon, but take more small Ensayes thereof, whereby you shall easily prove what Plate it contains, and what remedy is necessary to bring it to full perfection, which when it is attained, and the refined substance alone contains the aforesaid proportion of Quicksilver and Pellet, strow some Quicksilver loose upon it, and therewith gently repass it two or three times in such manner as it may go into the Copper better bathed, in the proportion of three parts Pellet, and two of Quicksilver, or at least two of Pellet and one of Quicksilver; then gather up some of the *Lis* that remains, and put it to the dry Plate, and to the whole Mass of Pellet, whereby they will be more weighty, and sink better to the bottom of the Caldron, and will rise and wast less in the boyling; throw Quicksilver also loose into the Caldron (which they call a Bath) when it begins to be liquid, incorporate therewith that which the Caxon contained, and it will

will help to unite it the better, and the more Quicksilver there was, the fewer inequalities like Oyster shells will be produced.

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## CHAP. XXI.

*That the washing of the Caxones causeth the loss and waste of Quick-silver.*

**A**LL the inconveniences that are and have been found in the waste of Quicksilver, which they term either loss or consumption of it, are caused by the washing the Caxons; until then nothing hath been lost, however one may be deceived in Judging by the view even in occasions, that have sometimes happened and may happen again, that they find neither Quicksilver nor Pellet of incorporated Metall in the Caxon; for accidents alone as hath been said, cannot alter the Quicksilver so as to corrupt and destroy its substance; in the Caxon it is howsoever more or less disposed to get out inperceptibly with the

the water or with the Lamas. The immediate cause of this mischief is when the Quicksilver is made over thin without body or weight as it were, so that it hath nothing to sink it to the bottom of the Caldron, and with the stirring the Caxon when they wash it, it mixeth it self with the dreggs and durt, and goes along with them, and there wants more or less of the Quicksilver they put in at first, according to their better or worse stirring the Caxon and quantity of *Lis*. It hath been a great error in those, that because for so many years the best Refiners in these Kingdomes have wasted at the least so much Quicksilver, as they have gotten Plate, therefore the Quicksilver is really and truly consumed in the operation, not animadverting the evidence to the contrary, which continually passeth through their hands, namly in the Lamas and relicks of the Caxon where the Quicksilver hath oftentimes stayed behind, accompanied with a considerable quantity of Plate, which the owners of Oar have experimented to their great damage, and

and the buyers and Refiners of the relicks of the Caxon to their great profit and advantage. Others speaking Philosophically say, the cause of the consumption of the Quicksilver proceeds from the contention and combat, which it hath with contrary qualities before it can lay hold on the Plate, and that thereby it is debilitated and consumed; these men say something to the purpose if they could demonstrate the contrary qualities that are between Quicksilver and other Mettals, between whom there is rather a great sympathy & agreement, Quicksilver being the principal whereof all other Mettals are made, and also of the Minerals that ordinarily do accompany them, but if these men cannot prove the cause, neither will the effect which they suppose, namely the destruction of Quicksilver follow, and there is certain experience to the contrary, and hereafter shall be shewed a way how to recover all the Quicksilver, even out of the Caxon, that is most spoiled in operation, and so most difficult to do it in.

CHAP.

CHAP. XXII.

*The true causes of the loss of Quick-silver, and their remedies.*

**T**He repassings are the remote cause of wasting of the Quicksilver, which is thereby strained and divided into very small parts which they call *Lis*, and although into whatsoever Oar, Earth or Sand you throw Quicksilver, and repass it, you shall find the effect aforesaid, yet it is most of all experimented in those Oars which are called *Soroches*, which by their weight and glassie quality, do more easily cut asunder, and divide the Quicksilver into minute parts.

Copperas is of its own nature a violent cause of extenuating the Quicksilver, as hath been often said, and hath been the cause of the wast of the greatest part of the Quicksilver that hath been destroyed. There be other causes, which accompany and assist the two former in working this ill effect, one is the

the Salt, which they use in Refining, and wherewith they wash the Caxones, which every body knows thickens water, whereby not only the small *Lis* of Quicksilver, but also heavier things swim and cannot sink to the bottom.

The Lamas which is mingled with the water, and troubles it in the Caldron thickens it, and doth yet more resist the sinking of the Quicksilver which stays and is thrown away together with it.

Lastly, the motion of the instrument wherewith they stir the Caxon when they wash it by condensing the force of the causes aforesaid, hinders the *Lis* from sinking, and crowdeth it up to the top. The ordinary repassings in this way of Refining cannot be wholly excused in this matter, but if the rules already taught, be carefully observed, the damage will be the less: likewise already hath been shewed the way to clear Oar from the Copperas, and to clear the Margagitas from their heavy and glassie qualities. Salt may be gotten out of the Caxones two several wayes, and pre-

preserved for use to the saving of many Ducats a year, now commonly spent in that commodity; put the Oar into Caxones made smooth and round on the inside without corners or Angles as is often used, let them stand a little slooping, only so much as is necessary, that all the water may run to one part of it, where there must be a hole for it to run out at in convenient season, but ordinarily kept stopped. When the Caxon is ready for washing, fill it with abundance of water, opening and stirring about the Oar with the hove, that the water may penetrate through it the better, and having done so a pretty while, open the hole, and let the water out into a Vessel provided on purpose to receive it, where it will either congeal into Salt, or remain in liquor as it is, will be serviceable for the operation of other Caxones; repeat this two or three times untill the water that comes out doth not taste brackish. If the Caxon was to have been washed in three Caldrons wash it in six, whereby the water will come out twice as clear,

clear, and with very little Mud, or Sediment.

The Pestel wherewith they stir the Caxon, must not be used always in the same hand, because the cricles going constantly paralel, the small parts of the Quicksilver, and the dry Plate go along together with them, and never encounter one another to unite themselves into a bigger body that they may sink to the bottom, wherefore after five or six turns with the right hand, take as many more of the left, and so proceed; and because this cannot so conveniently be done in the ordinary washing places, put into the Caldron a thing like a broad Peel, which opposite to the course and motion of the pestel may disturbe the march of the Quicksilver and dry Plate, and cause all the content of the Vessel to meet and unite, excepting that which is at the bottom whereof there is no necessity, because of the bath which it is to suffer. Cover the Vessel with Plates of Copper, or Iron Quicksilvered, to which side soever of the Vessel the *Lis* comes, it may

may stick thereunto, when the Caxon is washed the *Lis* is easily gotten together, by sweeping the sides of the Vessel with a peece of shoo leather, a peece of a hat, or a peece of cloath.

## CHAP. XXIII.

*To make the Pine Apples, and to clear them of the Quicksilver.*

HAVING taken the Plate and Quicksilver together out of the Caldron, and straining it through two course cloaths wetted, to make them the thicker, having beaten it also with a Battledoor to squeeze as much Quicksilver through the cloathes as is possible, make Pine Apples of the dry Pellets in moulds fitted for that purpose, which are called Pine Apples from their similitude to that fruit by reason of their Pyramidal figure, and

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of

of those Pines that have been reasonably well strained, the fifth part will be Silver, so that one Hundred pound of Pellets will produce twenty pound weight of Silver. The Pines that are made of richer Oar arise to less profit than those that are made of poorer, because the Plate in the richer Oar is more coarse and spongy, than that which is contained in the poorer. In the straining of the Quicksilver though never so carefully, some small parts of the Silver will go along with it, and the more in quantity by how much the more moysture there was in the Pellets when they began to strain them, the like whereof is seen in water mixed with clay, which although it be strained with never so much care, will not look clear and pure but muddy and troubled by reason of its mixture with the durt, and the great quantity of water there was, the more durt straines through along with it; letting it stand quietly a while it will settle and gather it self together, and leave  
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the water clear. In like manner, in the Vessels wherein they preserve the Quicksilver after they have done refining, and made the Pine Apples, after a few days the Pellets of Silver will settle and gather into a body together. In the refining work of Saint *Catherines* in the *Lipes* out of the Vessel, wherein they kept their Quicksilver, I saw as much Plate gotten of the kind aforesaid, as would have made a good great Pine Apple.

If the Quicksilver be heated it becomes thinner, and will carry away more Silver in the straining, also when the Pellets are strained, that are gotten by boyling although it be done with very much care, yet Plate will pass along with the Quicksilver, and if you will let it stand a days time to cool and settle, and strain it again, you will get more Pellets of Silver.

The loss in clearing the Oar again from the Quicksilver hath been great and irrecoverable, as may be guessed from the experiment thereof in this Imperial City at this present, when the Trading in Mettals runs but low, and yet *communibus annis* above thirty thousand peeces of Eight are wasted by the expence of Quicksilver, how vast a sum then hath been spent by Quicksilver in the many other very rich Mines belonging to this Kingdom; this inconvenience hath proceeded from want of care in seeing that the Canones and Caperucas (which are the names of the Vessels they use in the recovering the Quicksilver) be made of very good stuff, and shut curiously close in the Place where they joyn together. The clay whereof usually they are made is very spungy and full of Pores, so that the water soaks through and sweats out at them; then it is no wonder that the Quicksilver attenuated by the violence of the fire (which widens the Pores of

of the Vessel also) evaporates through the same, and is exhaled and lost: to say that any part of the Quicksilver is destroyed or perisheth by the heat of the fire is onely the imagination of those that understand not the uniformity of its substance, as hath been shewed before. Make the Caperucas and Canones of such stuff as you make the Crusiples, and that inconvenience will cease, and the Vessels will last for ever (because they are so mightily condensed and resist the fire) unless some accidental blow or knock do break them. In that noble Town of Saint *Phillipi* of *Austria*, *Oruro*, famous for abundance of Mines both of Gold and Silver, on the top of a little hill which stands above the Church of the *Ranqueria*, there is a little vein of white earth, whereof they make Vessels for use, which after they are baked become so close and firm that they are not inferior to the best *China*. I was the first that made try-

all, and published the usefulness of it for the making of Crucibles with very good success to those that had need of them, and I do not doubt but there is such kind of Earth about this City of *Potosi*, where nothing hath been found wanting that any wise belonged to the obtaining or refining of that abundance of riches, which nature hath bestowed upon it; although hitherunto much business, and a short time of abode here, hath hindered me from finding of it out. But where such kind of earth is wanting, mingle the Clay whereof you make these Vessels, the better with the scum or dross of Iron grownd very fine, and make it up and bake it very well, and there shall not be so much *Quicksilver* lost in the use of them as is by those now in common use. The Canones must be glaz'd on the inside, the *Caperucas* not, because the violent heat will melt the glazing, and make it run.

CHAP.

## CHAP. XXIV.

*Other safer ways of clearing the Pine Apples from Quick-silver.*

THE best Vessels for this purpose are made of Iron or Copper beaten to the thickness of a peece of Eight, or somewhat thinner, and for more security, that the Vessels may the better endure the fire, they cover the Copper Vessel with a coat of good earthen ware on the outside; not many years ago, some people began to use these Copper Vessels cased with earthen ware, and left them off again, because they understood not the nature of them, nor how to use them. The like happened in the Province of the *Chickas*, who cased their refining Vessels as abovesaid, because they heard that in their neighborhood in the *Lipes*, I was working after that

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man-



manner. The cause of these mistakes shall be shewed in the discourse which follows.

The shortest, best, and most secure way of clearing the Pine Apples from Quicksilver is in this manner ; make a deep Vessel of Iron wider at the top than at the bottom , containing more or less according to the quantity of Mettal intended to be cleared at one time, set it upon a Trevet of strong Earthenware, or of Iron cased with Earth in a Furnace of sufficient bigness to put Wood or Coals under it, as occasion shall require at a mouth made for that purpose ; the rest of the Furnace both the top, bottom, and sides is to be very close ; excepting one little hole at the top where it shall be found most convenient to give respiration ; dispose the Vessel aforesaid in such manner as they do that which they call the Cannon in the ordinary way of using Quicksilver ; so that it may look out above the

the top of the Furnace one large finger bredth or two, that it may the better joyn with another Vessel to be put a top of it, which may serve instead of the Caperuca ; put the Pellet (or Mettle aforesaid) well kneaded together in Cakes of what form you please into the Vessel, and lest the Plate should melt and stick to the Iron Vessel, let it have a thin coat on the inside of Earthen ware ; or such as Crucibles are made of, cover this Vessel with a large Limbeck head made of hammer'd Iron, or Copper, or of very good Earthen ware well glaz'd, and out of it draw a long Pipe a little sloping, the cavity whereof in the narrowest Place, namely the extremity, let be no lesser, than the bigness of ones little finger, let the joyning of the Limbeck with the Vessel below it, be stopped very close with gault, then in a secure place that doth not feel the heat of the Furnace, let there be placed a great Vessel of stone or of other matter full of cold water, where-

whereinto let the nose of the Limbeck enter two fingers breadth, blow up the fire in the Furnace from which the Quicksilver flying in the form of vapor to the top of the Limbeck, the coolness whereof presently reduceth it into a body again, which runs down through the Nose into the Vessel of water aforesaid, the Limbeck should now and then be cooled on the outside with wet cloaths, and the water into which the Quicksilver falls as it becomes warm should have more fresh water added to it.

A. The deep Vessel of Iron, or Copper.

B. The head of the Limbeck.

C. The Nose of it.

D. A Trevet.

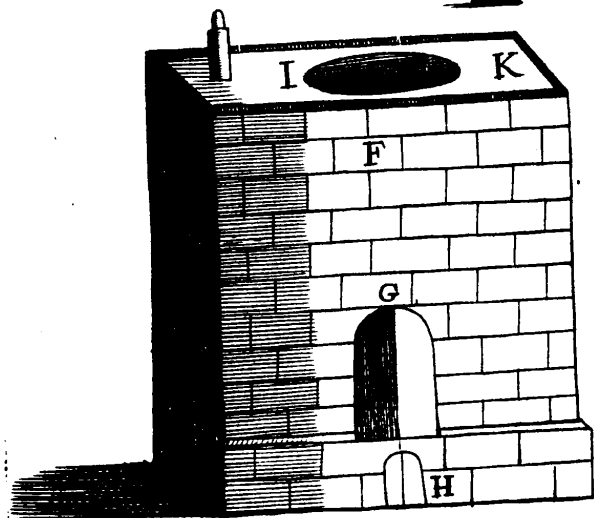
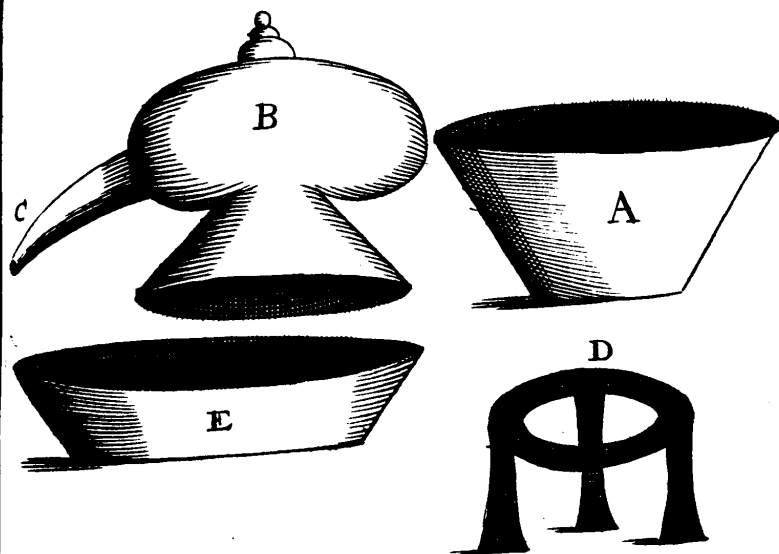
E. A Bason or Vessel of water to receive the Quicksilver in.

F. The Furnace.

G. The Mouth of it.

H. The hole to draw out the ashes at.

I. A



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I. A hole open at the top of the Furnace, whereat the deep Iron Vessel looks out a little, and is joyned to the Limbeck,

K. Is a Chimney to let out smoak and give respiration to the fire.

*Here place the Pictures and the Verses.*

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The trouble and hazard of keeping them close in the joynt with clay or gault, may be excused by making of the place where they shut one upon the other a handfull and a half higher, or if to that size of them, that is now in use they put at the bottom on the outside, and fill it of two fingers broad ; so that the lower Vessel may come up very close upon it, and cannot enter further into it, a little lower than the Caperucas come, are placed the Candlestick foot, as they call it, whereupon they set the Plate and the Pine Apple ; the Candlestick foot comes up about four fingers higher than the mouth of the lower Vessel, which they call the Canon in the which on the one side four or six fingers lower than the fire used to be, enters in a small Pipe of cold water at a hole made for that purpose in the Canon without disturbing the Caperuca at all, because it is not to go in strait, but with a little liberty ; over against this hole there is such another, out of which runs as much water as enters in at the former,

former, whereby the Canon is always kept full, and the water in good temper to receive the Quicksilver without any prejudice.

If one separates the Quicksilver by the Limbeck, they may do the same thing, clapping a ring of Copper of two fingers breadth, and other two fingers deep to the mouth of the lower Vessel ; so that the other Vessel may easily be let in and out, wherein the Quicksilver is to be saved. Into this Circle the Limbeck must be fitted, and to prevent its being blown off with the force of the vapor of the Quicksilver, the Limbeck must be kept down with weight on the top of it, or tying it to some other fixed thing, or making a ring on the top of the Limbeck pass a bar of Iron through it, both ends whereof afterward remaining fixed in two walls built on each side of it for that purpose.

F I N I S.